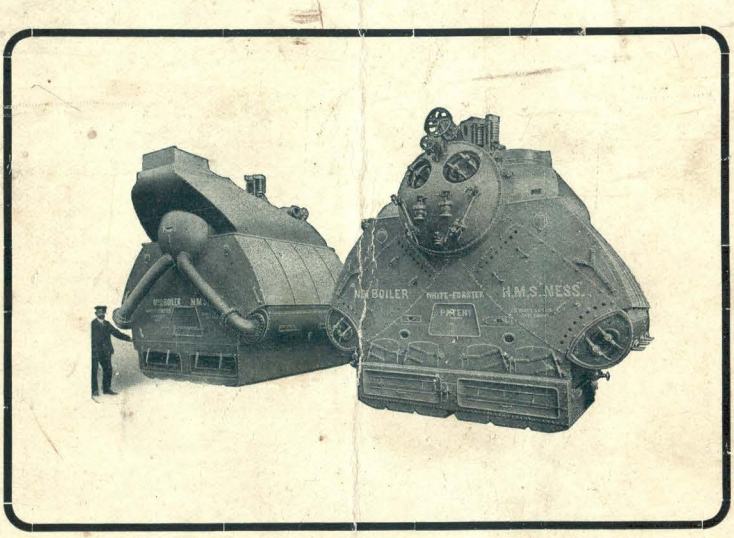
BABCOCK & WILCOX LTD.,

PATENTEES & MAKERS OF

GENERAL LICENSEES & MAKERS OF

Babcock & Wilcox Boilers,
White Forster Boilers.

MARINE BOILERS



WHITE-FORSTER PATENT WATER-TUBE BOILER

MANUFACTURED
BY

GENERAL LICENSEES:

Babcock & Wilcox Ltd.,
Oriel House,
Farringdon St.,
London, E.C.

PATENTEES:

J. Samuel White & Co., Ltd.,
East Cowes,
Isle of Wight.

MARINE
Water-Tube Boilers

Babcock & Wilcox Patents.
White-Forster Patents.

MANUFACTURED BY

BABCOCK & WILCOX LIMITED,
LONDON, ENGLAND,

AND THE

BABCOCK & WILCOX CO.,
NEW YORK, U.S.A.

LONDON AND NEW YORK,
AUGUST 1908.

BABCOCK & WILCOX Limited.

Head Offices :

ORIEL HOUSE, FARRINGDON STREET, LONDON, E.C.

Telegraphic Address :
" BABCOCK," LONDON.

Head Office Telephone :
No. 5540 Holborn (4 Lines).

DIRECTORS :

JOHN DEWRANCE, M.I.C.E., M.I.M.E., ETC. (*Chairman*).
ARTHUR T. SIMPSON, M.I.C.E., M.I.M.E.
WILLIAM D. HOXIE.
F. G. BOURNE.
CHARLES A. KNIGHT, M.I.M.E., A.S.M.E.
JAMES H. ROSENTHAL, M.I.M.E., ETC.
WALTER COLLS (*Secretary*). (*Managing Director*).

OFFICES :

GLASGOW : 29, St. Vincent Place.
MANCHESTER : 14, Deansgate.
NEWCASTLE : 42, Westgate Road.
MIDDLESBROUGH : The Exchange.
CARDIFF : 129, Bute Street.
BIRMINGHAM : Winchester House, Victoria Square.
SHEFFIELD : 14, Bank Chambers, Fargate.
BRUSSELS : 68, Boulevard du Nord.
MILAN : 4, Via Dante.
MADRID : 1, Ventura de la Vega.
MELBOURNE, Victoria : 9, William Street.
SYDNEY : 427 & 429, Sussex Street.
MONTREAL : New York Life Insurance Co.'s Buildings, 11, Place d'Armes.
TORONTO : Traders' Bank Building.
MEXICO : Centro Mercantil, 3er Piso, No. 25.
LIMA : Peru.
BOMBAY : Hornby Road, Fort.
CALCUTTA : 10, Clive Street.
YOKOHAMA, Japan.

DISTRICT OFFICES :

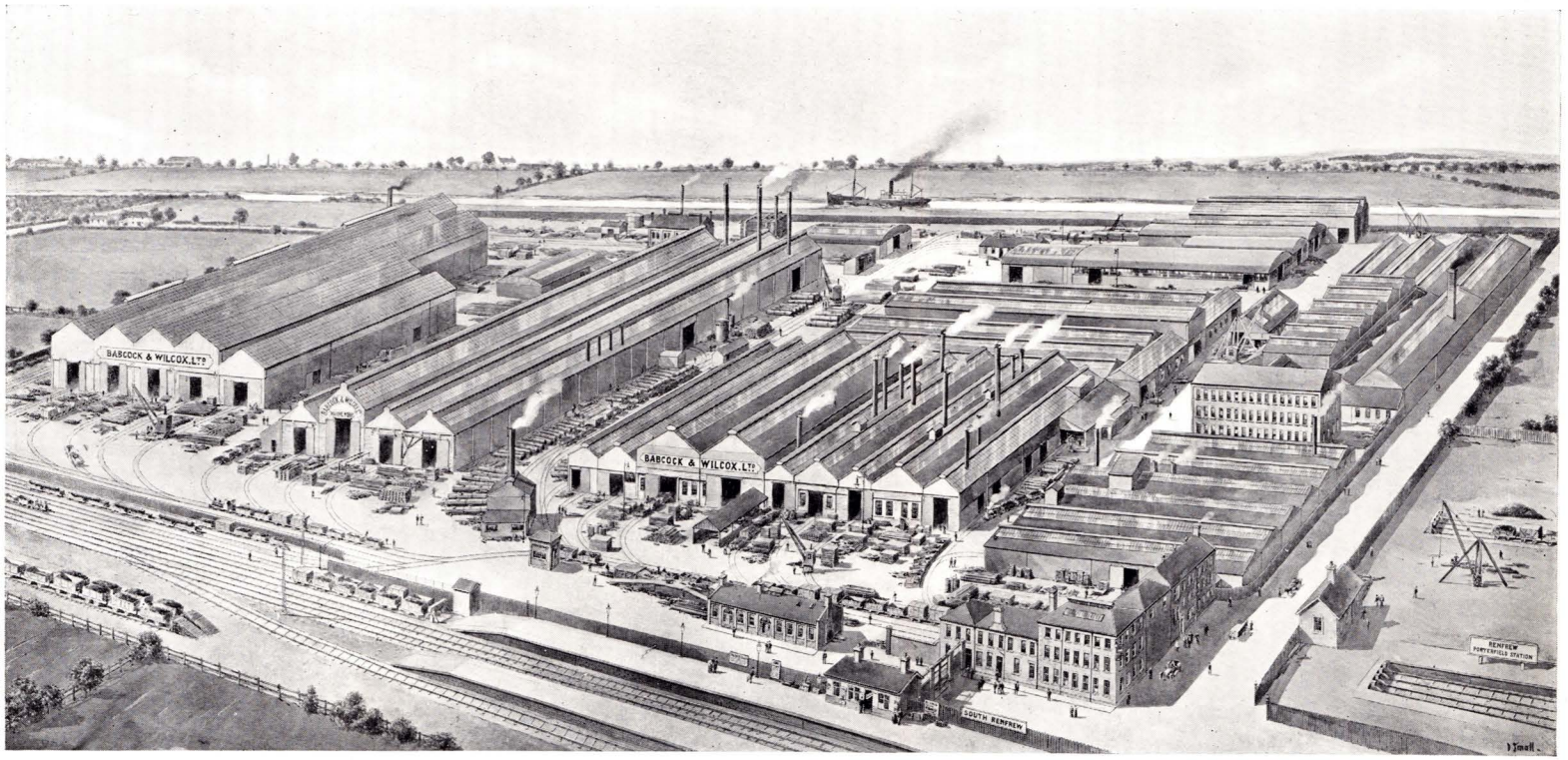
BELFAST : OCEAN BUILDINGS, DONEGAL SQUARE EAST.
IPSWICH : GORDON TERRACE, KEMBALL STREET.

REPRESENTATIVES :

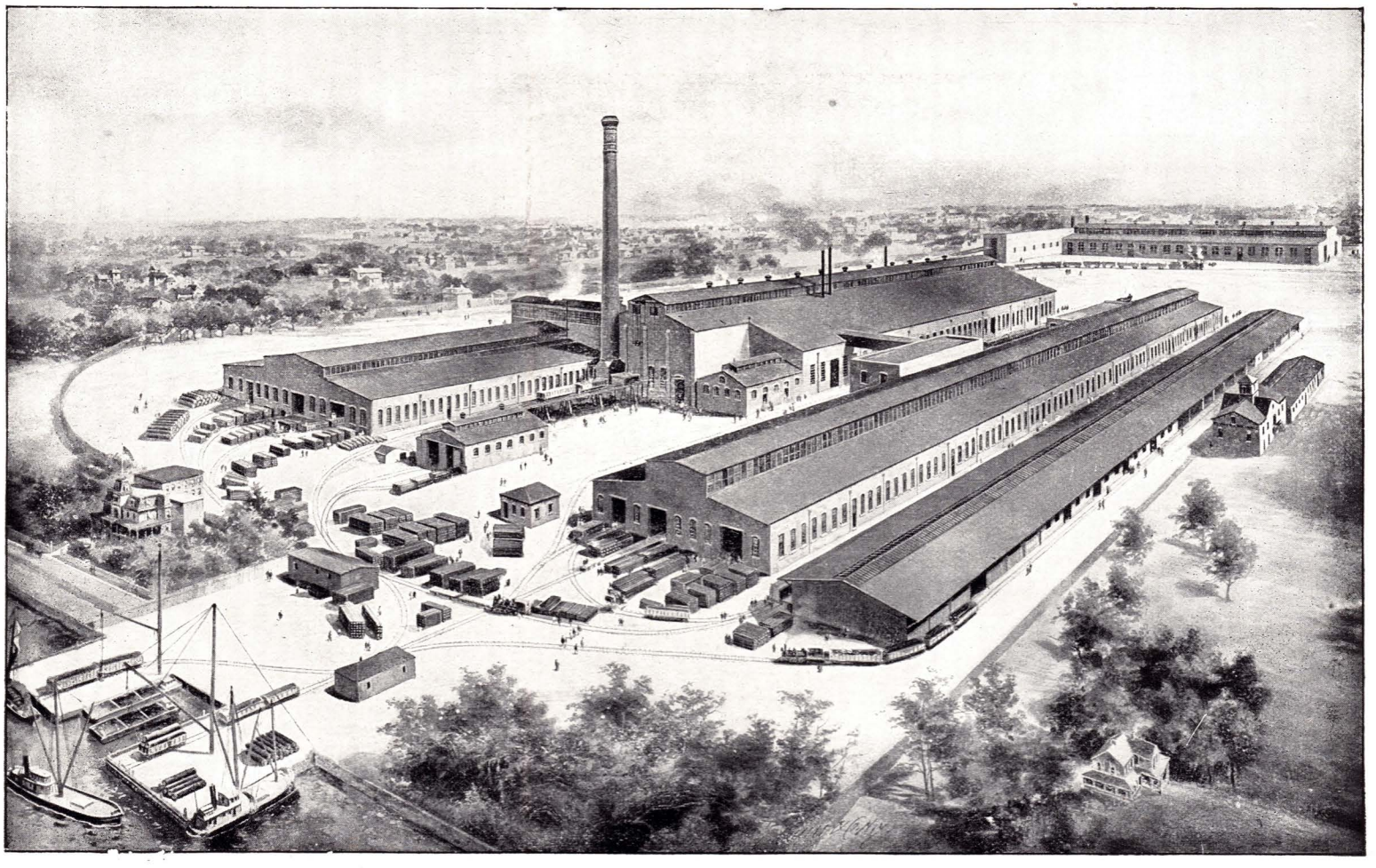
ADELAIDE, South Australia : TODD & SAMUEL.
ATHENS, Greece : A. D. ZACHARIOU & Co.
AUCKLAND, New Zealand : JOHN CHAMBERS & SON, LTD.
BARCELONA, Spain : MORGAN & ELLIOT.
BILBAO, Spain :
BRÜNN, Austria : ERSTE BRÜNNER MASCHINEN FABRIKS-GES.
BUCHAREST, Roumania : ACTIEN-GESELLSCHAFT FUR MASCHINEN-HANDEL, &C., VORMALS E. BEHLES.
BUDAPEST, Hungary : DANUBIUS SCHOENICHEN-HARTMANN.
BUENOS AYRES, Argentine Republic : AGAR CROSS & Co.
CAIRO, Egypt : BRITISH ENGINEERING Co. OF EGYPT, LTD.
CHILE, S. America { ALEXANDER YOUNG (LONDON), LTD. / JOHN R. BEAVER (Valparaiso).
CHRISTIANIA, Norway : A/S. THUNES, MEKANISKA-VÆRKSTED.
COLOMBO, Ceylon : WALKER, SONS & Co. LTD.
COPENHAGEN, Denmark : AKTIESELSKABET BURMEISTER & WAIN'S MASKIN-OG-SKIBSBYGGERI.
ESKILSTUNA, Sweden : MUNKTELLS MEKAN-VERKSTADS AKTIEBOLAG.
GIJON, Spain : MORGAN & ELLIOT.
JOHANNESBURG, South Africa : REUNERT & LENZ.
KIMBERLEY, South Africa : REUNERT & LENZ.
LISBON, Portugal : JOHN M. SUMNER & Co.
MOSCOW, Russia : JOHN M. SUMNER & Co.
PERTH, Western Australia : McLEAN BROS. & RIGG.
POLAND : DEUTSCHE BABCOCK & WILCOX-DAMPFKESSELWERKE ACT.-GES. : 1, KAISER WILHELMSTRASSE, BERLIN.
PORTO ALEGRE, RIO GRANDE DO SUL, RIO DE JANEIRO } Brazil : GUINLE & Co.
RANGOON, Burma : IRRAWADDY FLOTILLA Co.
SMYRNA, Asia Minor : RANKIN & DEMAS.
ST. PETERSBURG, Russia : JOHN M. SUMNER & Co
TAMMERFORS, Finland : SANDMAN & Co.
THE HAGUE, Holland : W. SCHLUSEN & Co.

Telegraphic Address for all Offices (except Bombay and Calcutta), " Babcock.

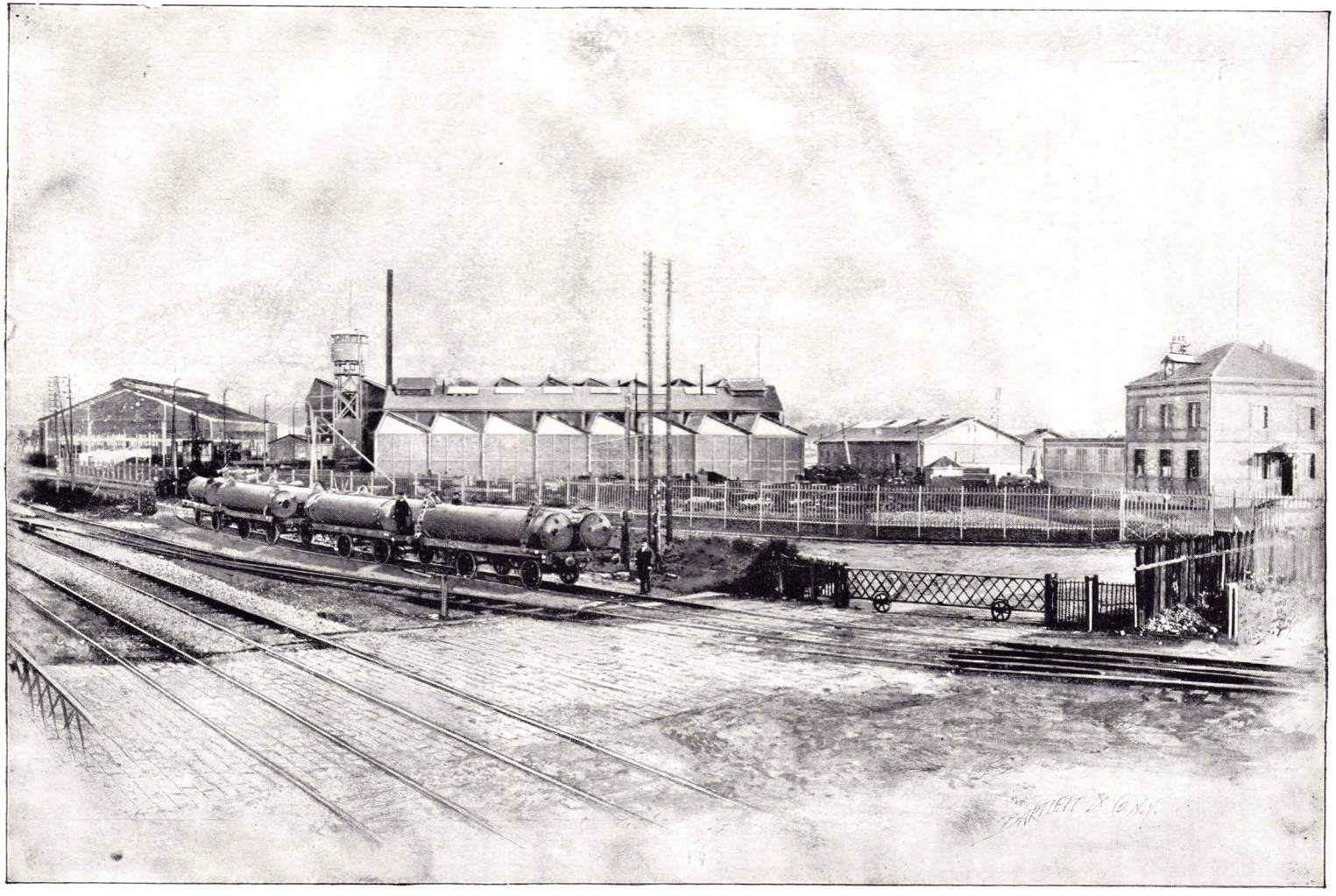
Works : RENFREW, SCOTLAND.



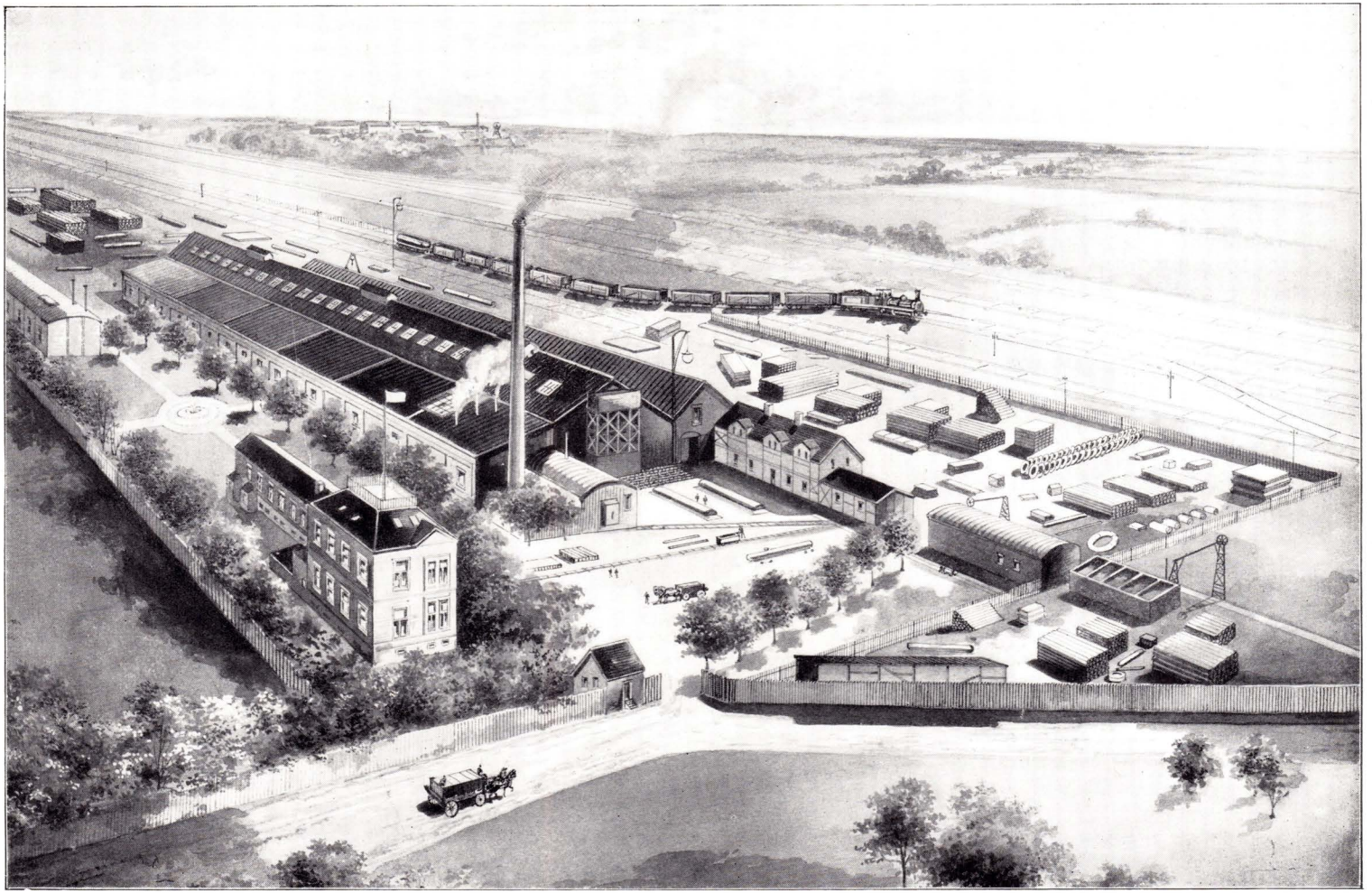
WORKS OF BABCOCK & WILCOX LTD., RENFREW, SCOTLAND.



WORKS OF THE BABCOCK & WILCOX COMPANY, BAYONNE, N.J.



WORKS OF THE FONDERIES ET ATELIERS DE LA COURNEUVE, Chaudières BABCOCK & WILCOX, PARIS, FRANCE.



WORKS OF THE DEUTSCHE BABCOCK & WILCOX-DAMPFKESSELWERKE ACT.-GES., OBERHAUSEN, GERMANY.

THE "WHITE-FORSTER" MARINE WATER-TUBE BOILER.

ALTHOUGH the use of the Babcock & Wilcox Boiler is constantly increasing in the Mercantile Marine, and in the larger types of naval vessels throughout the world (see "Babcock & Wilcox Catalogue of Patent Water-tube Marine Boilers," 1907 edition), there are many cases in which the reduction of weight to the utmost limit for a given power is of paramount importance. This mainly applies to Torpedo Boats, Torpedo-Boat Destroyers, Scouts and vessels of light draft, but there are cases of large vessels where these conditions exist.

In such cases the "White-Forster" Boilers—as introduced and now largely supplied for the British Navy by J. Samuel White & Co., Ltd., of East Cowes—not only fully meets these conditions, but presents great advantages compared with other boilers that are used for similar purposes. This Boiler :

1. Is **simple** in design and construction.
2. Is easy to inspect, clean and **repair.**
3. Has ample **steam space** in proportion to the **heating surface.**
4. Has all parts of mild steel.
5. In constructive details is based on established **boilermakers' practice.**
6. It is already largely used both for Coal firing only, Oil firing only, or a combination of both.

In any type of water tube boiler the question of **removal** and **renewal** of any or all of the tubes is a very important one, and experience points to the following conditions in the lifetime of a boiler when this is necessary or desirable :—

1. During manufacture a tube in the middle of a nest may fail at the last stage of expansion by tube expander.
2. A tube may fail under water pressure test of completed boiler.
3. On inspection of boilers by Receiving Officers after trial, they may discover some point in connection with any one tube and wish it removed.
4. On periodical inspections of conditions of boilers a sample tube from each row will reveal the actual condition.
5. Probably the rows next the fire, if the service has been very severe, or the use of the Fire Extinguisher has been injudicious, may require renewal before any other tubes in the boiler.
6. Complete renewal owing to fair wear and tear.

The "White-Forster" Boiler is designed so that the foregoing conditions can be met with no more difficulty than is experienced in a fire tube boiler, and all the necessary repairs can be made by the ship's staff.

DESCRIPTION OF THE "WHITE-FORSTER" WATER-TUBE BOILER,

MANUFACTURED BY

BABCOCK & WILCOX LIMITED,

LONDON AND RENFREW.

PRINCIPAL FEATURE.

ANY SINGLE TUBE CAN BE REMOVED AND RENEWED IN HALF-AN-HOUR.

General Features.

By reference to Figs. 1 and 2 (pages 12 and 13), it will be seen that there are two lower water drums connected by the generating tubes to an upper steam and water drum, the water level being arranged as to entirely drown all the tubes.

The radius of curvature of each tube is the same, and the curvature is only sufficient to determine the direction of movement due to expansion, and also to facilitate cleaning and repairs.

Cleaning.

The tubes are arranged in position in a transverse section, like the staves in a section of a barrel, and the continuation of the line of curvature of each tube, passing through the top drum in line with the end manhole, allows each tube to be inserted or withdrawn through this manhole, so that it is possible to withdraw any tube without disturbing the remaining tubes, and as every tube has the same curvature it can be readily cleaned, internally, by a tube brush having a rigid handle curved to the same radius.

Material.

The boiler and its casings are constructed entirely of mild steel, no castings of any kind being employed. Large downtake tubes are fitted. Ordinary manhole doors are fitted to all drums, studded doors being avoided. The design is such that its construction in every detail makes it what may be termed a **"simple boilermaker's boiler."**

Circulation.

As the inclination of the generating tubes is considerable, and usually varies between 40° and 60°, the circulation is definite and rapid, keeping the tubes free from deposit. No special water baffles or separator plates are found necessary, the usual internal steam pipe being sufficient to give dry steam.

Combustion.

Special care is taken in designing the casings and uptakes in order to make the boiler as efficient as possible. No plates or other baffles are fitted amongst the tubes which would interfere with tube sweeping, but patent baffles are fitted to divide the uptake into two or more parts, in such a manner that the gases are drawn **equally** over the whole tube surface, **and at right angles to it,** without offering any resistance or increasing the air pressure. Air holes are arranged at the sides and ends for the admission of air above the grate; sight holes are fitted for the inspection of the uptakes and combustion chamber.

Cleaning.

Large doors are fitted at the front end, so that the whole length of tubes is exposed for cleaning, and a brush can be passed between the tubes from end to end of the boiler.

Directions for Working.

In the case of the "White-Forster" boiler it is not thought necessary to issue any special instructions. If the water level is at working height and the boiler clean, it has been proved that from 10 lbs. to 120 lbs. of coal per square foot grate can be burnt efficiently without damage to the boiler.

THE "WHITE-FORSTER" WATER-TUBE BOILER.

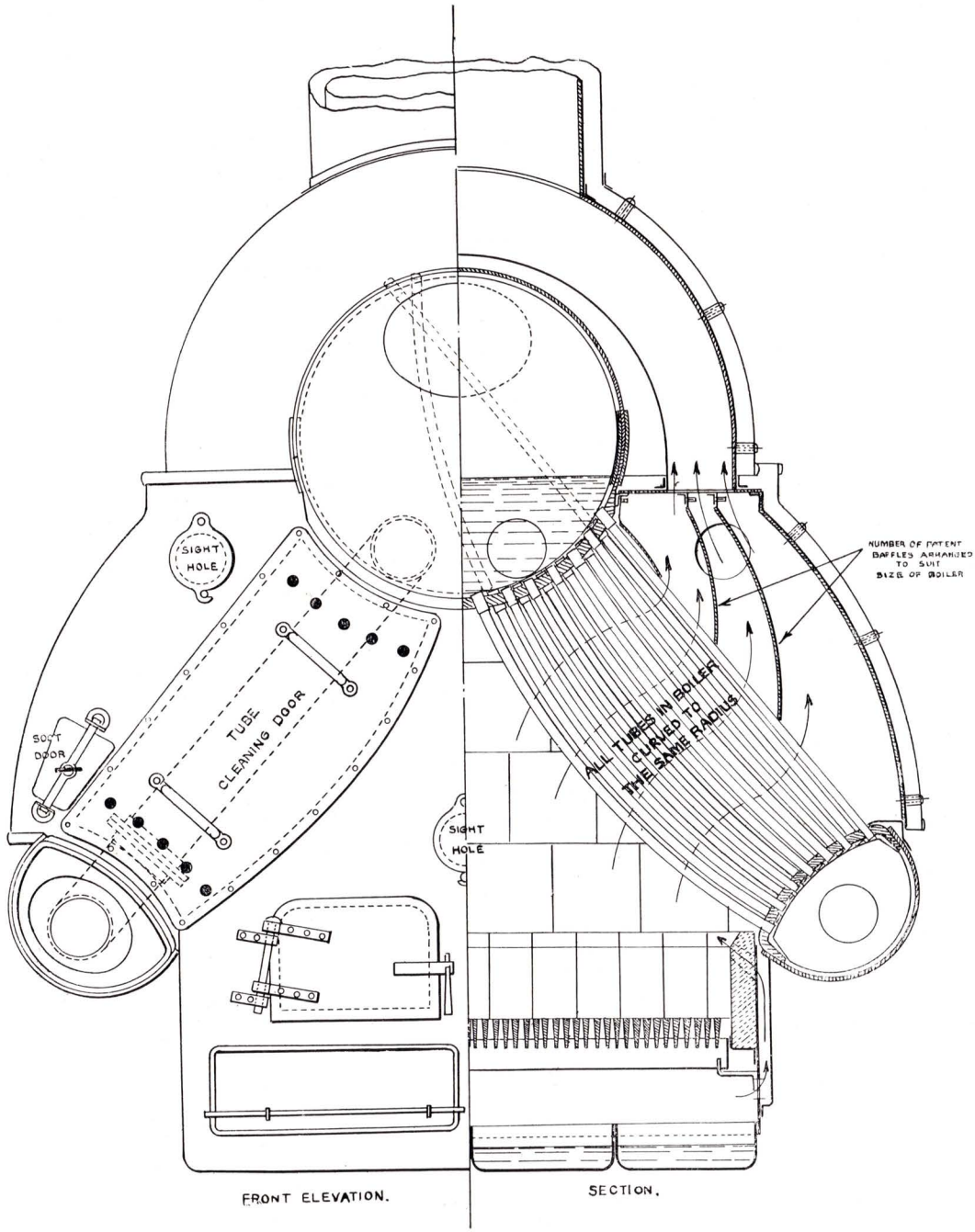


Fig. 1.

THE "WHITE-FORSTER" WATER-TUBE BOILER.

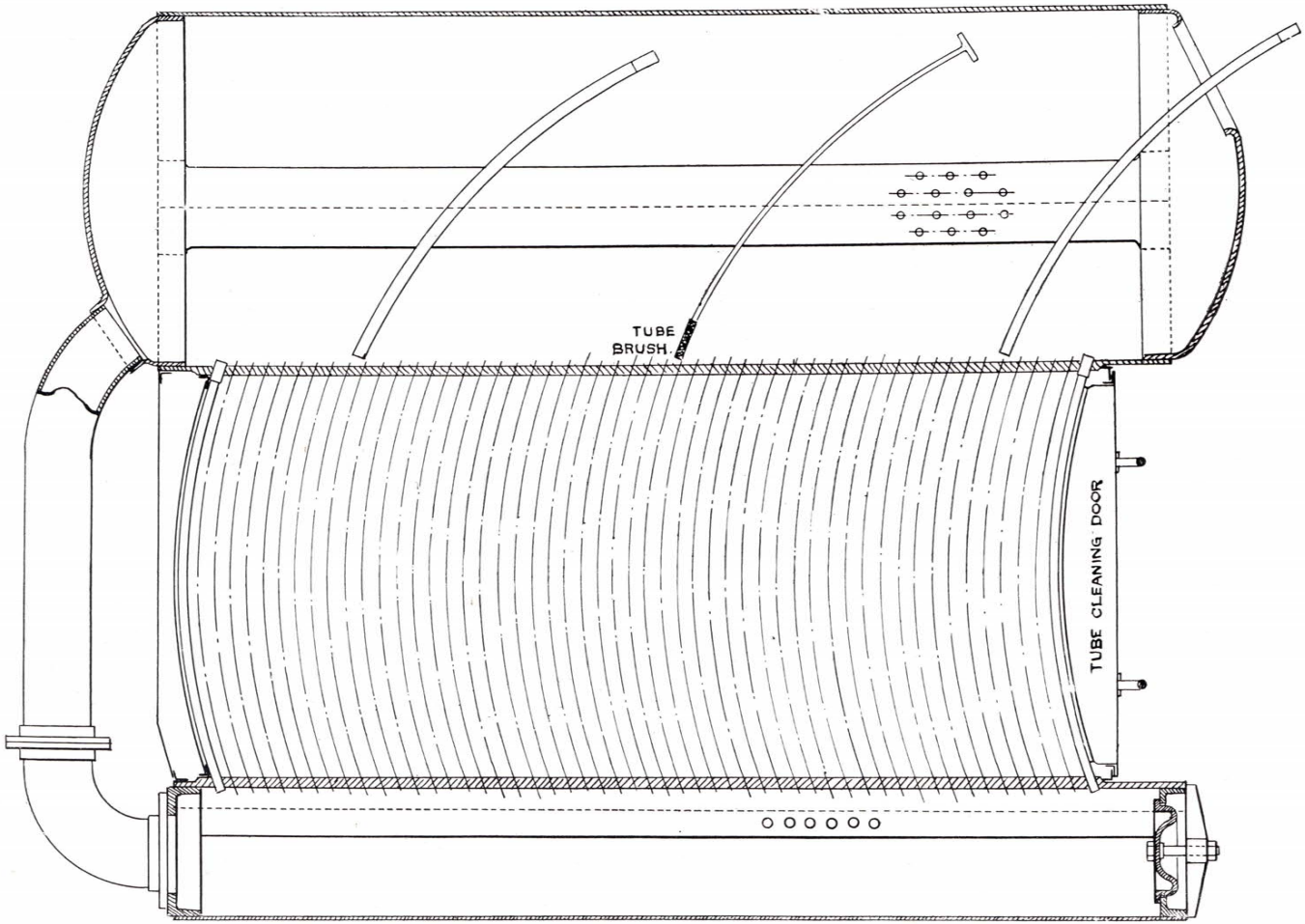


Fig. 2.
Longitudinal Sectional Elevation.

PRACTICAL POINTS.

IN the **"White-Forster" Boiler** the slight curvature of the tube is sufficient to determine the direction of movement due to expansion, and **prevents distortion** when the rate of working is very high, as in Torpedo Boats and similar craft.

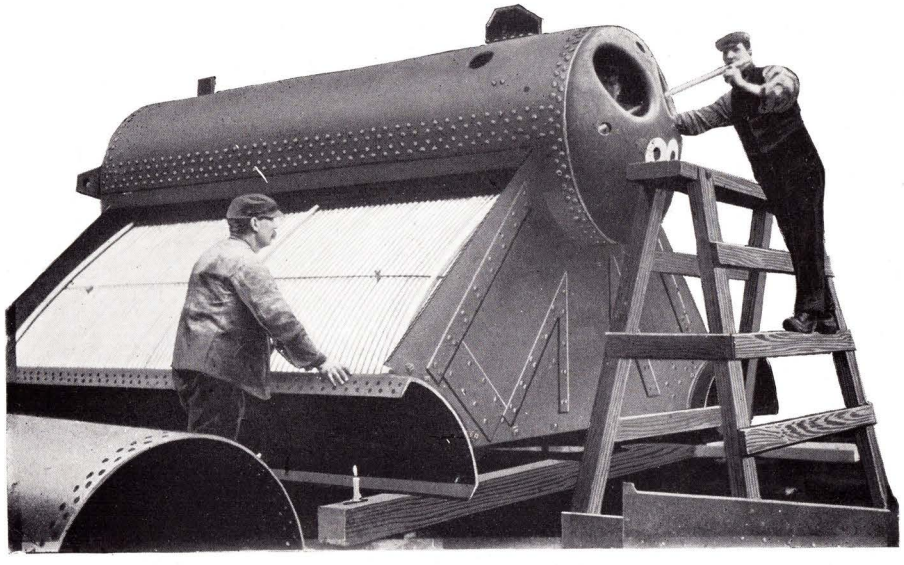
All the tubes are of the same curvature, and spare gear is simplified accordingly. The tubes can be drawn into the drum, thus avoiding the removal of several tubes to get at a defective one, which is necessary with other express type boilers.

This Boiler can also be made with large tubes when desired, and where comparatively low rates of combustion are contemplated.

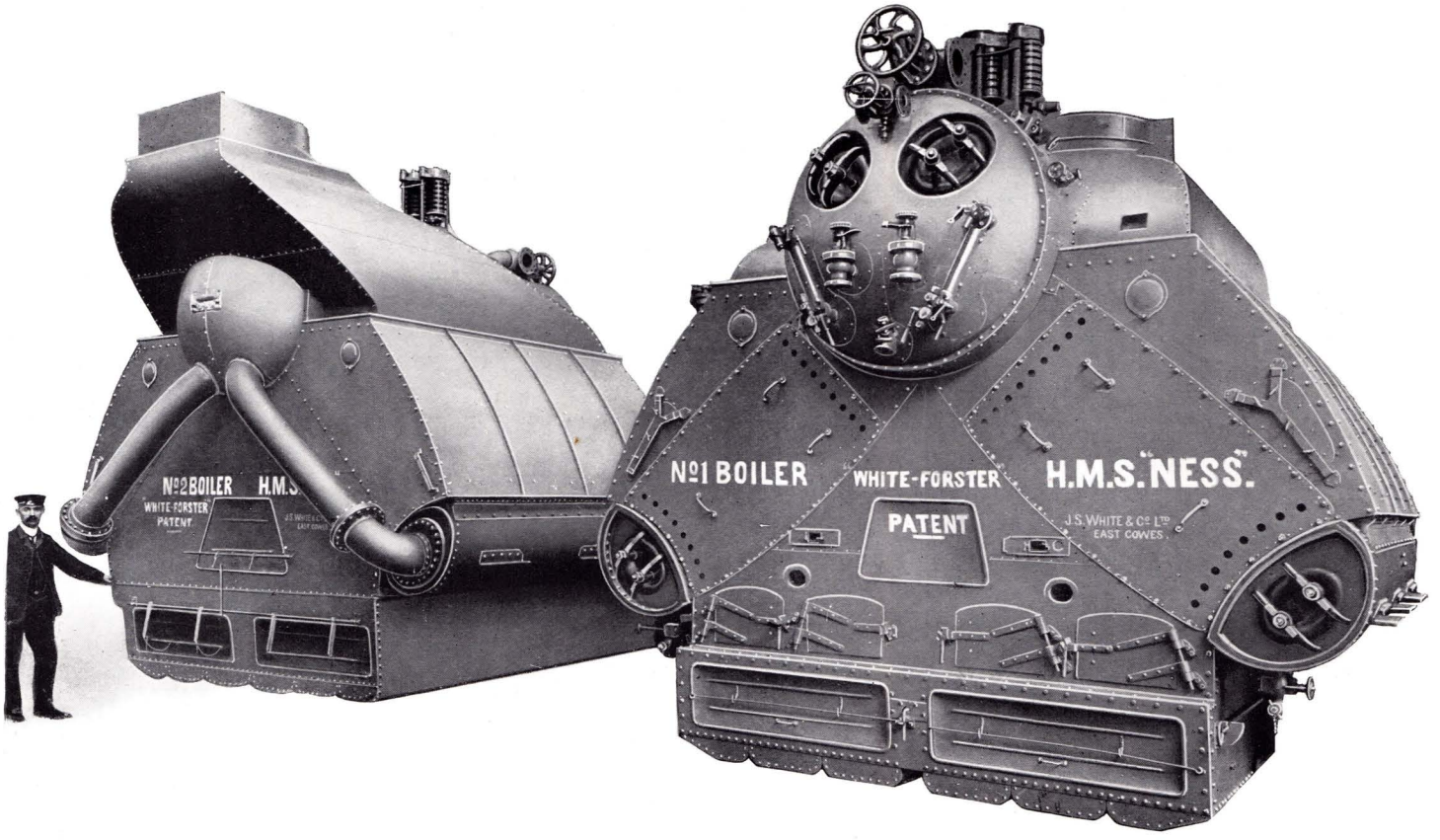
DESIGN SUITABLE TO MEET THE SPECIAL FEATURE OF WITHDRAWING SINGLE TUBES.

THE point has often been raised whether the increase in size of drum required to provide for the withdrawal of tubes when it is necessary to use a **longer tube** than usual does not **hamper the design.**

In reply to this it need only be stated that boilers, each of **one unit**, have been made to supply steam for 100, 200, 250, 350, 450, 550, 650, 750, 1,000, 1,250, 1,500, 1,750, 1,850 to 2,500 I.H.P., and that designs have been prepared for 3,000 I.H.P. Some with natural, mostly with forced, draught, the grates have been wide and short, narrow and long ; tubes have been short, and tubes have been long, to suit all the various conditions raised



2,000 I.H.P. Boiler for H.M.S. "CRICKET" Coastal Destroyer being tubed.



Two of the Boilers, each 2,000 I.H.P., as fitted in the River-class Destroyers H.M.S. "NESS" and "NITH," showing front and back.

SPARE TUBES.

AS a general rule (unless specification clauses do not permit) the tubes are galvanized in the straight and bent afterwards.

Spare tubes can be carried in straight pieces, of the maximum length, already galvanized, and can be bent and cut as required.

A simple machine is used for bending the tubes. This is constructed on the principle of horizontal rolls—two fixed lower rollers grooved to diameter of tubes desired to be bent, and a top roller adjustable up and down also grooved.

A small hand machine of this type, which will easily bend all the tubes required, can be supplied for each ship. The cost of such a machine would be from £5 to £7 10s.

There is one feature in rolling material to a definite curve which must not be lost sight of in connection with the tubes of these boilers.

When a round boiler shell is being rolled into shape from one plate, it is found that about 6 inches either side of the butt joint is not curved to the radius of the shell, but is practically straight. Platers "set" these edges sometimes beforehand, sometimes afterwards. Now the tubes of the "White-Forster" Boilers are similar. When curved, the first two inches or so at each end is practically straight. The holes drilled in the tube plates of course, are straight also, so that the tubes fit the holes perfectly. It has been asked, "How is a curved tube made to fit a straight hole?" It is not! The ends of the tubes are not curved, or, if so, are so slightly curved that driving the tube in straightens them.

The following is a copy of instructions supplied (with a chest containing a complete set of tools) to each ship fitted with a

"WHITE-FORSTER" WATER-TUBE BOILER.

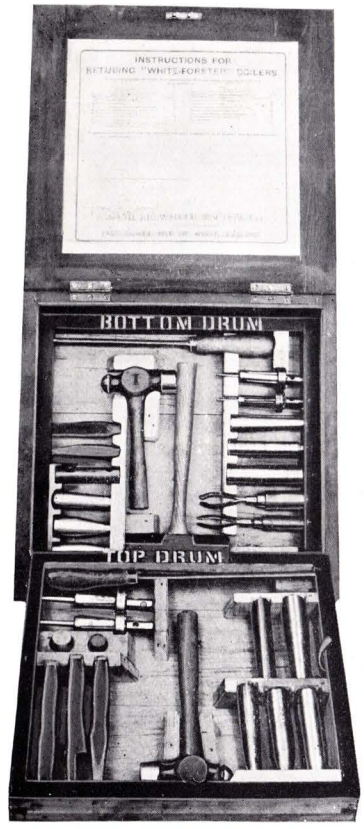
TO REMOVE AN OLD AND FIT A NEW TUBE, ASSUMING THE BOILER SUFFICIENTLY LARGE TO ALLOW MEN TO ENTER THE STEAM AND WATER DRUMS:

REMOVE zinc slabs or internal pipe hangers should they be in the way.

Before disturbing the tube, measure its length as fitted, and cut the new tube $\frac{1}{8}$-inch longer to allow for loss in length due to bell mouthing.

1. Take a small "round nose cross cut," and make one groove in the top end of the tube to the full depth of the tube plate—not cutting right through the thickness of the tube, but leaving just a skin to protect the hole.

2. Take a fish back tool (recognised boilermakers' tool in smoke tube boiler work for easing tube ends when drawing tubes) and insert it each side of the above groove, closing in the end of the tube ; use this also on the opposite side of the hole, freeing the tube from the hole.



3. Cut off the end projecting in the lower barrel. An ordinary hand chisel can be used for this, a short shaft hammer being necessary.

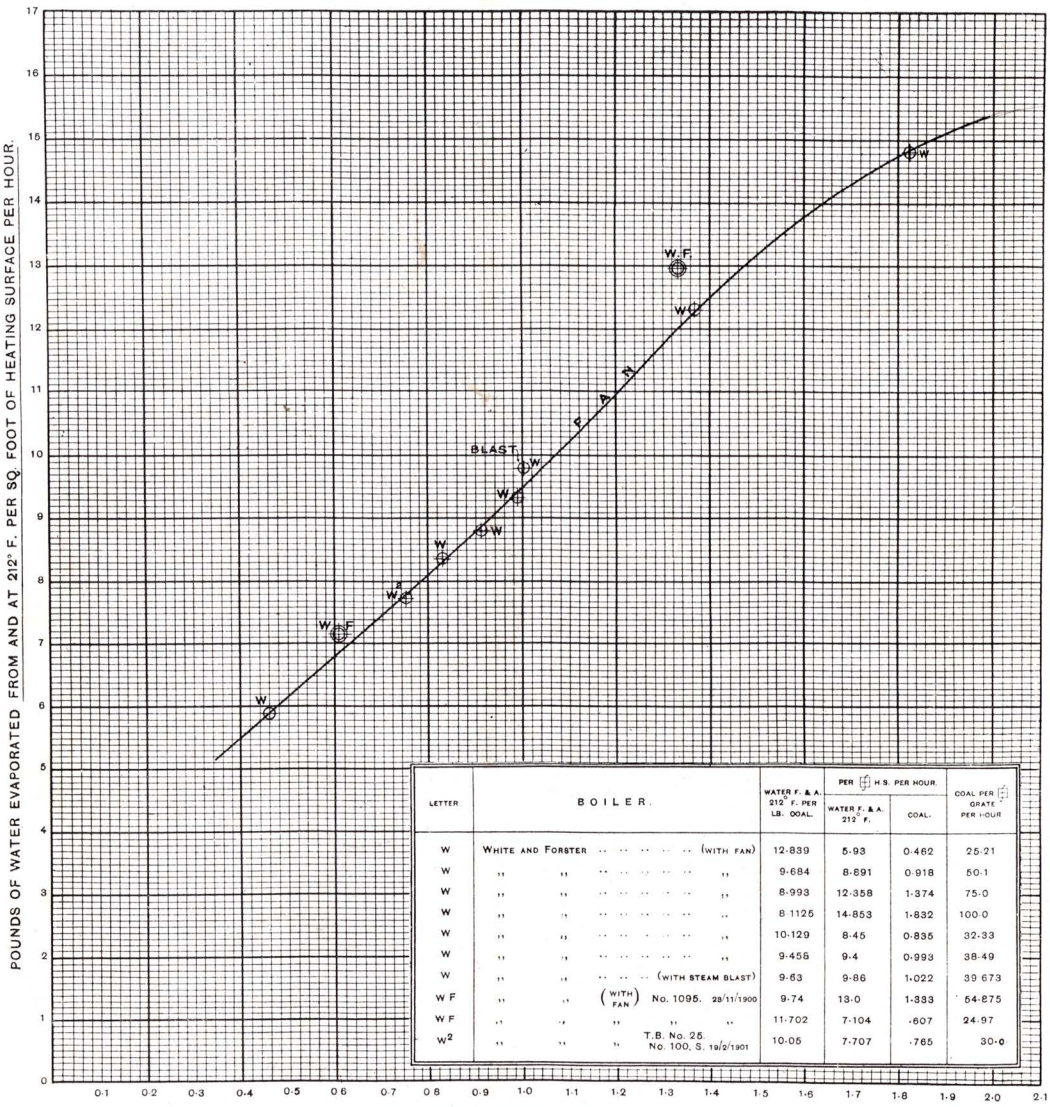
4. Insert a short driver in the bottom end, and with a short shaft heavy hammer drive the tube up through the plate. The moment the tube is out of the upper plate it is free to pull out by hand.

5. Put the new tube in from the top, lead up a small rod (expander mandril will do) through the bottom hole to receive the end, and bring it to the tube hole. As soon as it enters put a rivet driver in the top end, and drive down gently with a hand hammer to the required distance. Drift both ends with a taper drift to secure the tube in position while expanding. Expanding does not differ from other types.

STEAM EFFICIENCY.

SPECIAL attention is given to the conditions under which the boiler is to work. The various proportions of heating surface, grate, combustion chamber volume, areas of air inlets above and below the bars, form and dimensions of uptakes, steam drums &c. are so designed that the highest possible efficiency is obtained. In the diagram below, the curve is constructed to eliminate the variable ratio of heating surface to grate surface, and thus give a fair comparison of various boilers. Only official trials are given.

OFFICIAL EVAPORATIVE TRIALS OF THE "WHITE-FORSTER" BOILERS.


POUNDS OF WATER EVAPORATED FROM AND AT 212° F. PER SQ. FOOT OF HEATING SURFACE PER HOUR.
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
0·1 0·2 0·3 0·4 0·5 0·6 0·7 0·8 0·9 1·0 1·1 1·2 1·3 1·4 1·5 1·6 1·7 1·8 1·9 2·0 2·1
POUNDS OF COAL BURNED PER SQUARE FOOT OF HEATING SURFACE PER HOUR.
W
W F
W²
BLAST

LETTER	BOILER.	WATER F. & A. 212° F. PER LB. COAL.	PER ⊟ H.S. PER HOUR. WATER F. & A. 212° F.	PER ⊟ H.S. PER HOUR. COAL.	COAL PER ⊟ GRATE PER HOUR
W	WHITE AND FORSTER .. .. (WITH FAN)	12·839	5·93	0·462	25·21
W	,, ,, ... ,,	9·684	8·891	0·918	50·1
W	,, ,, ... ,,	8·993	12·358	1·374	75·0
W	,, ,, ... ,,	8·1125	14·853	1·832	100·0
W	,, ,, ... ,,	10·129	8·45	0·835	32·33
W	,, ,, ... ,,	9·456	9·4	0·993	38·49
W	,, ,, ... (WITH STEAM BLAST)	9·63	9·86	1·022	39·673
W F	,, ,, (WITH FAN) No. 1095. 28/11/1900	9·74	13·0	1·333	54·875
W F	,, ,, ,, ,, ,,	11·702	7·104	·607	24·97
W²	,, ,, ,, T.B. No. 25. No. 100. S. 19/2/1901	10·05	7·707	·765	30·0

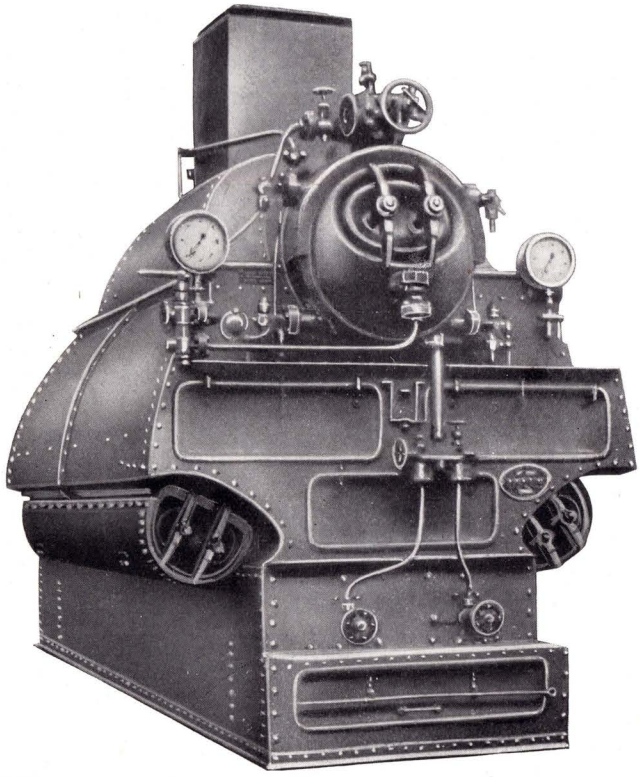
THE ABOVE RESULTS ARE ALL FOR COAL FUEL.

STEAM EFFICIENCY—*continued.*

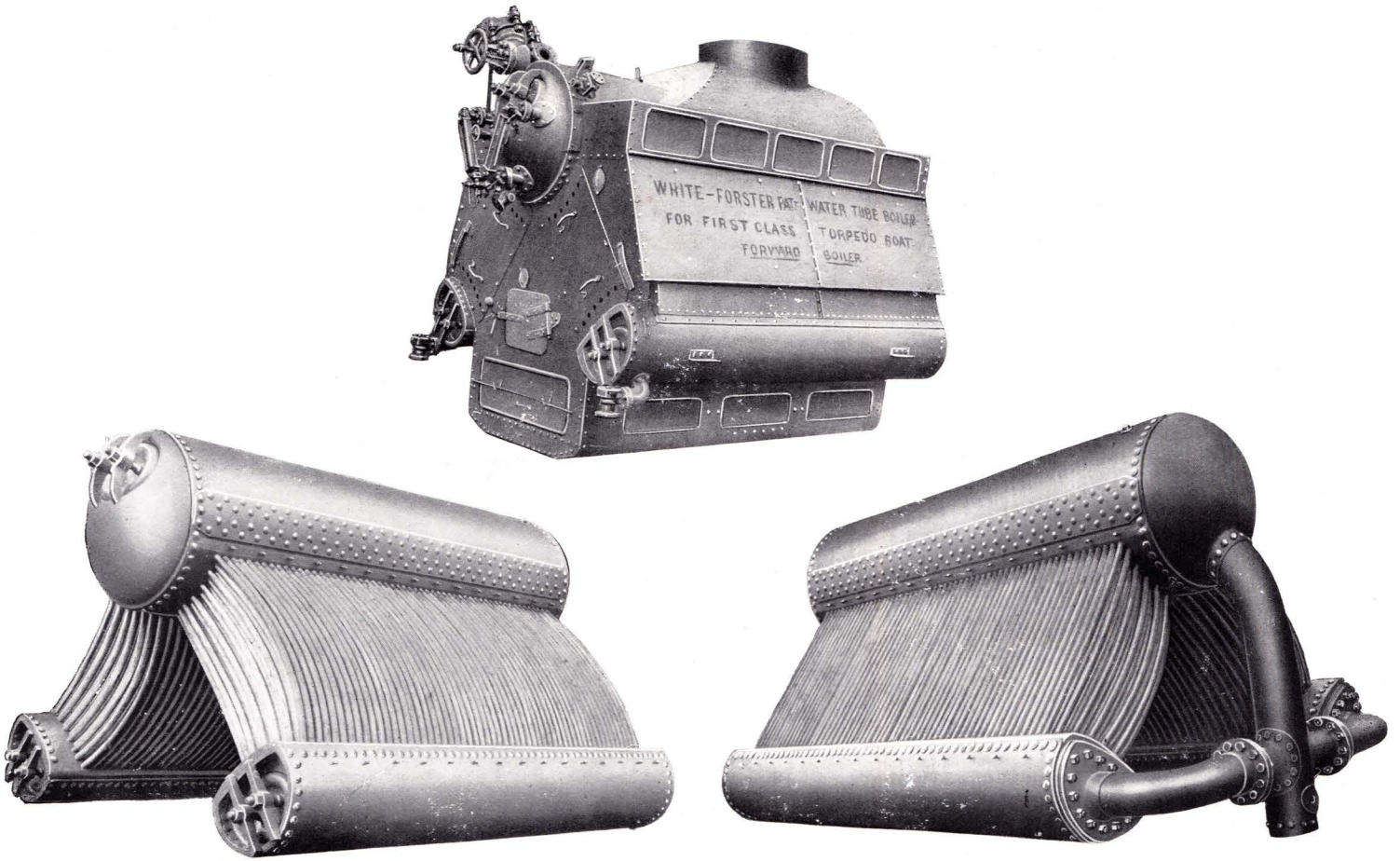
EVAPORATIVE RESULTS WITH OIL FUEL.

(AVERAGE).

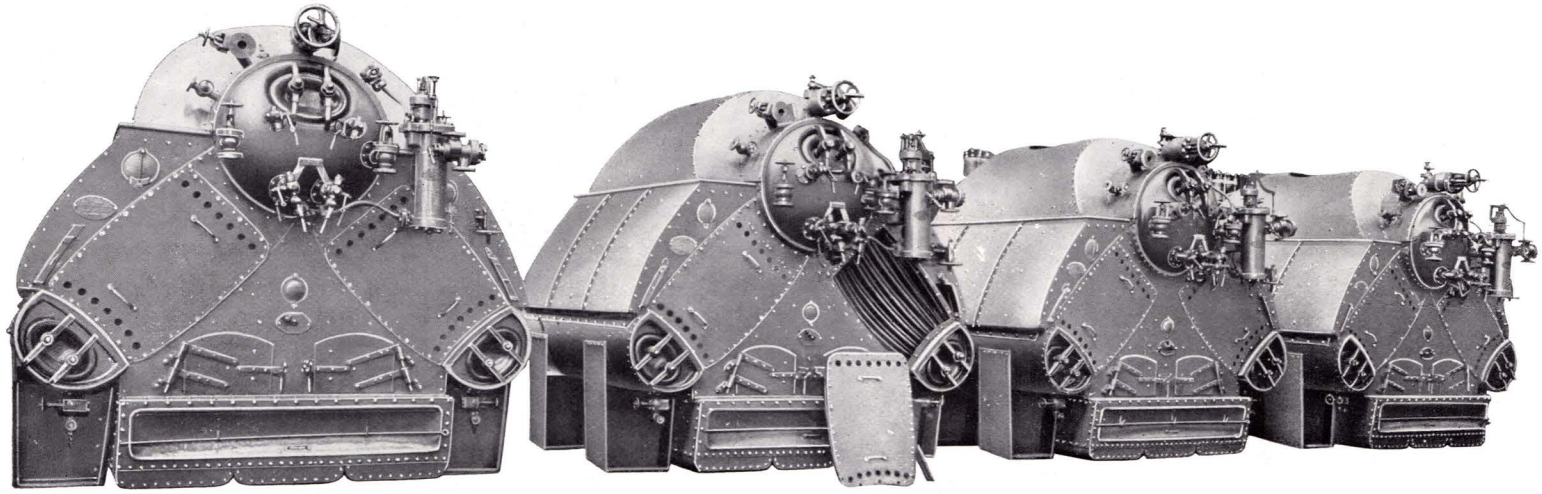
Evaporation Trial, One Boiler.	Full Power.	Low Power.
Duration of trial	2 hours.	2 hours.
Heating surface	4,000 square feet.	4,000 square feet.
Volume of combustion chamber	302 cubic ,,	302 cubic ,,
Mean Results, per Hour.		
Water evaporated (actual)	45,410 lbs.	15,750 lbs
Oil burnt	3,800 ,,	1,145 ,,
Water evaporated per lb. of oil fuel actual	11·94 ,,	13·75 ,,
,, ,, ,, from and at 212° F.	14·5 ,,	16·7 ,,
Water evaporated per square foot of tube surface actual	11·35 ,,	3·93 ,,
,, ,, ,, from and at 212° F.	13·61 ,,	4·75 ,,
Oil burnt per square foot of tube surface	0·950 ,,	0·2865 ,,
Oil burnt per cubic feet of combustion space	12·6 ,,	4·82 ,,
Steam pressure lbs. per square inch	205 to 212	200 to 207
Oil ,, ,, ,,	210 to 220	100
Air pressure in stokehold (inches of water)	4·6 to 4·9	0·95 to 1·0
Oil temperature at burners	F. to 215° F.	180° F. to 200° F.
Temperature of atmosphere	77° F.	80° F.
,, ,, stokehold	88° F. Max.	90° F. to 97° F.
Smoke	Very light to nil.	Very light to nil.
Number of burners in use	11 (open ½ a turn).	4 (open ¾ of a turn)
	Total for Two Hours.	Total for Two Hours.
Water evaporated (actual)	90,820 lbs.	31,500 lbs.
Oil burnt	7,600 ,,	2,290 ,,



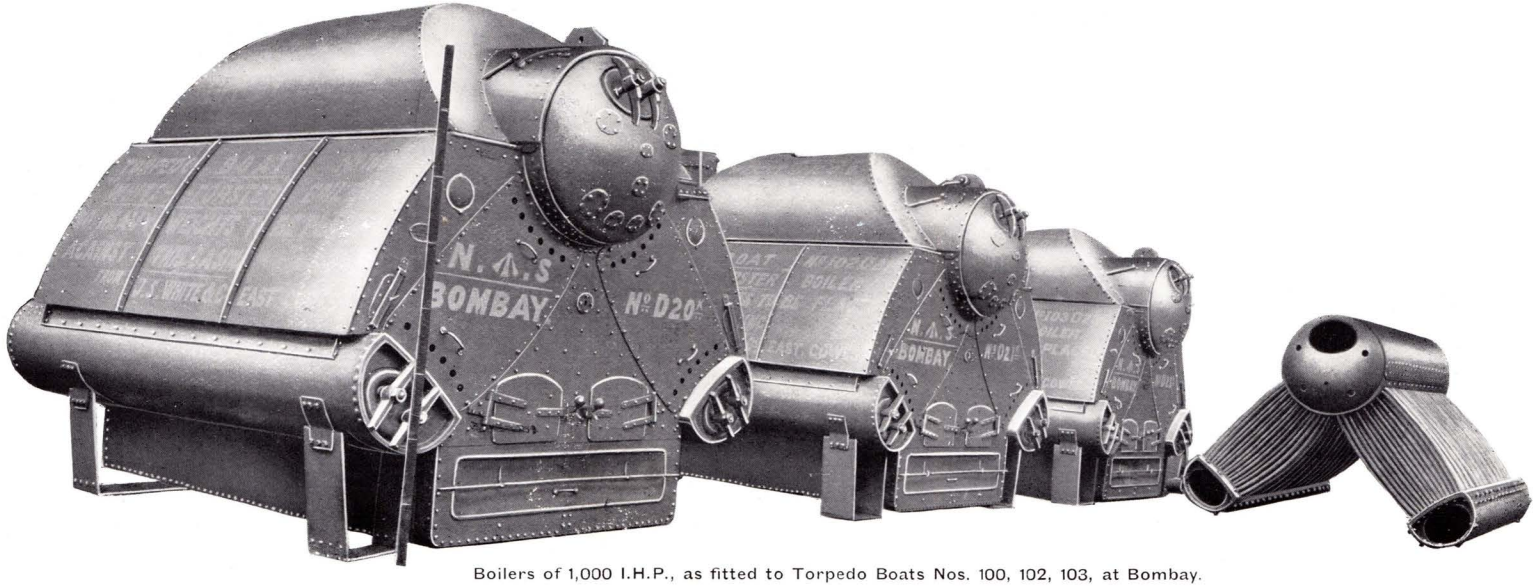
Boiler for Liquid Fuel Experiments at Royal Naval College Greenwich.



Three Views of Boilers, 700 I.H.P., fitted in First-class Torpedo Boats.



Boilers of 500 I.H.P. each, as fitted to first-class Torpedo Boats Nos. 35, 36, 37, 38, at Hong Kong.



Boilers of 1,000 I.H.P., as fitted to Torpedo Boats Nos. 100, 102, 103, at Bombay.

THE "WHITE-FORSTER" FEED REGULATOR

MANUFACTURED BY

J. SAMUEL WHITE & COMPANY, Ltd.,

EAST COWES, I.W.

Description.

THE "WHITE-FORSTER" FEED REGULATOR is of the external type, being connected to the Boiler by means of steam and water pipes and valves, so that at any time it may be isolated from the boiler for inspection.

Steam is allowed free access to the inside of the float ; internal and external pressures on the float are thereby balanced, and the float can be made of the lightest material, dispensing with the usual float balance weights.

Action.

The action is as follows :—

The piston P, which is worked by steam pressure in the small cylinder, is connected to the feed regulating cock by levers as shown. The steam to this piston is governed by the small valve V, which is worked by the float in the regulator. The steam to this valve passes through the float, entering at the top and leaving at the bottom ; this prevents water accumulating in the float, relieves it of all pressure, and enables us to make of thin sheet brass and without the usual balance weights.

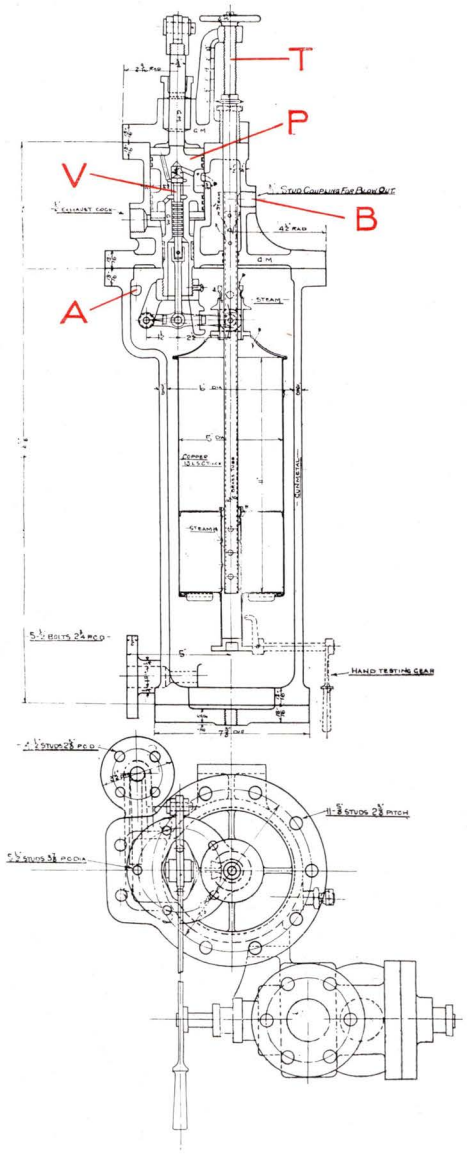
If the Water in the boiler falls, the float lowers the valve V, which admits steam to top of P, and drives it down until the steam port is closed, so that if the valve V falls $\frac{1}{4}$-inch the piston P falls $\frac{1}{4}$-inch ; on the other hand, if the water rises in the boiler the float raises V ; this connects the top of P with the exhaust, and the unbalanced pressure on the bottom part or small diameter of P forces it up until the port is again closed, so that the piston P copies exactly the action of the valve or the float.

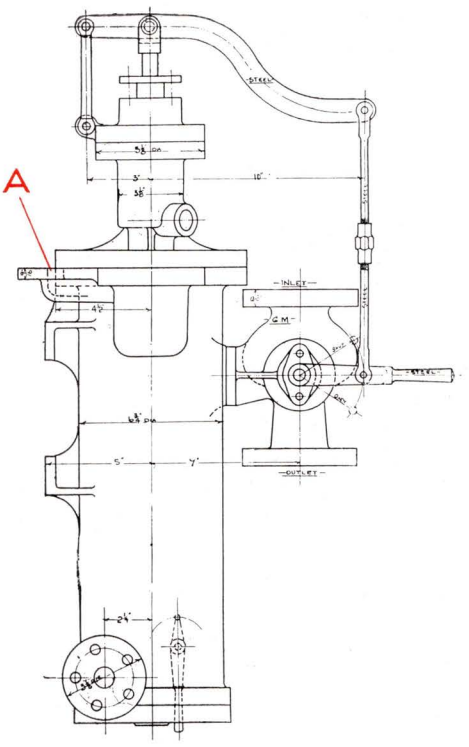
To raise the water level in the boiler the connection A is closed and B opened, this drowns the float, the tube T is then raised the desired amount by means of the wheel at the top, and A is opened ; as soon as dry steam appears at B, B is closed and the regulator is in working order. The effect of this is to fill the float an amount equal to the desired increase in water level.

To lower the water level, the tube T is lowered an amount equal to the desired alteration in water level, and B is opened ; when dry steam appears B is closed, and the regulator is again in working order.

A hand lever is attached to the feed water cock, so that the free movement of the outside gear can readily be tested.

At the bottom of the float chamber there is another lever so arranged that the free action of the float and its connections can be tested when necessary.





STANDARD
AUTOMATIC FEED REGULATOR,
"White-Forster" Patent.

Advantages.

The advantages of the Regulator are as follows :

1. Visible action.
2. Compactness.
3. Lightness.
4. All parts made of brass.
5. Float action not resisted by the friction of stuffing boxes and glands.
6. All working parts are attached to the top cover, and can be removed by breaking the joint.
7. Easily put in and out of gear.
8. Can be worked by hand if required.
9. No pitting of floats, &c.
10. When a nest of boilers is connected to one pump, springs may be connected to the lever, so that if the pressure falls in any one boiler below, say, 60 lbs. the spring acts against the float and closes the feed regulating cock. This would prevent all the feed water rushing to a boiler which had a burst tube, because as soon as the pressure falls the regulator would be shut off.

THE BABCOCK & WILCOX PATENT AUTOMATIC FEED-WATER REGULATOR.

THE Babcock & Wilcox Patent Automatic Feed-Water Regulator, which can also be fitted to "White-Forster" Boilers, is illustrated below.

Its chief advantages are :—

Simplicity. Certainty of Action.

The ease and quickness with which it can be adjusted.

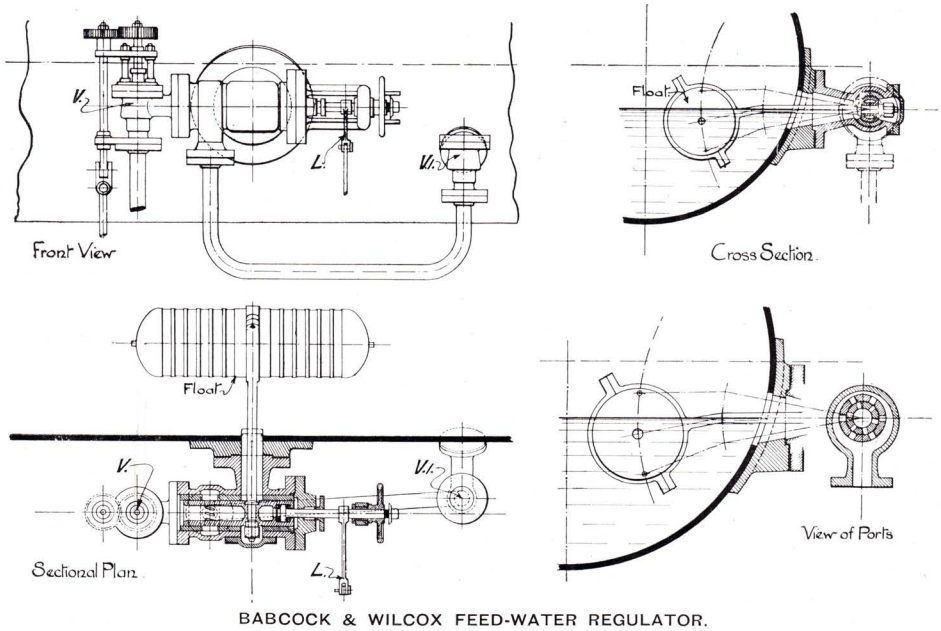
The small space it occupies, and

The almost entire absence of friction in its working parts.

During the working of this type of Feed-water Regulator, it has been demonstrated that the water level can be kept with absolute certainty, with only a very small variation from the normal.

The Regulator consists of a hollow cylinder, which is rotated on its axis by means of a float and lever placed inside the boiler. The cylinder has ports cut diagonally along its walls, and works in a liner having corresponding ports. The liner is fitted in a casting or box, which is attached to the boiler shell, and has one branch for a feed check valve, and another branch for a pipe leading to a non-return feed valve on the boiler drum.

The cylinder is moved lengthways along the liner by means of a suitable adjusting screw and spindle, the spindle being connected to the cylinder by ball-bearings, so that friction is reduced to a minimum.



BABCOCK & WILCOX FEED-WATER REGULATOR.

Attached to the spindle, between the adjusting wheel and the gland, is a lever and rod, the latter extending to a position in the stokehold, where it can be easily worked by hand from the firing level. The object of this rod and lever is to enable the water tender to ascertain that the float is moving freely when getting up steam, or to keep the float in the open or shut position, should circumstances at any time so demand.

The action of the apparatus is as follows :—

The feed-water enters by feed check valve V into the hollow cylinder C, and, if the water in the drum is low, passes through the ports of both cylinder and liner to the valve box, whence it travels through the pipe and non-return valve VI into the boiler.

The position of the cylindrical valve is entirely regulated by the float in the boiler. When the level of the water in the boiler is low, the ports will be open, and as the water rises in the boiler and carries the float with it, the cylindrical valve will be moved round, and the ports gradually closed. If the apparatus be kept clean and in good condition, the friction of all the working parts being thereby at a minimum, it will be sensitive enough to keep the opening of the ports just such as will maintain the water at a uniform level; at any rate, there should never be a difference of more than 1 to 1½ inches in the water level during the time the regulator is in action, and there should be no appreciable variation in the sensitiveness of the regulator when the boilers are worked at a high or a low rate of evaporation, or even when the rate is changed suddenly.

The height of the level of the water in the boiler can be maintained at the position desired by moving the cylinder lengthways along the liner. This is done by turning the hand-wheel of the spindle attached to the cylinder, the travel of which, as the ports in both cylinder and liner are placed diagonally, will ensure an alteration in the point of cut-off relative to the position of the float. It is usual to work the Babcock & Wilcox Marine Boiler with from 4 to 6 inches of water showing in the gauge glass, and the position of the regulator on the drum, and of the float, are so arranged that when the valve is in mid-position, this height of water will be regularly maintained, and any desired alteration of water level in either direction can be effected by the adjustment of the hand-wheel on the spindle.

There is a suitable indicator on the adjusting wheel showing which way it should be revolved for the higher or lower water level, and there is also an indicator on the spindle itself showing when the valve is at the highest, lowest, or any intermediate position.

The main points to be observed to ensure the satisfactory working of the regulator are as follows :—

CYLINDER.—The cylinder should be such a fit in the liner that it can be turned round by hand, but not loose enough to be shaken.

GLAND.—The gland on the adjusting spindle should be packed just sufficiently to keep it free from leakage, and this packing should be examined periodically and renewed when necessary.

JOINTS.—Owing to the variable temperature to which the regulator is exposed, the joints should be properly faced and very carefully made.

BALL BEARINGS.—When the spindle and cylinder are taken out for examination, great care should be exercised in collecting and replacing the balls in the bearings.

FEED CHECK VALVE.—It should be borne in mind that when a boiler is laid off, the boiler check valve should be shut ; otherwise, owing to the slight leakage due to the necessary clearance between the cylinder and the liner, the water will gradually find its way through the regulator, and the level be raised accordingly.

The pressure in the boiler feed pipes should not exceed about 1½ times the working pressure of the boilers, and the ratio between the steam and water cylinders of the feed pumps should be arranged accordingly.

The Babcock & Wilcox patent Feed-water Regulator has been fitted to the following vessels :—

	Ship.	Boilers.	I.H.P.
H.M.S.	"Hermes"	12	10,000
,,	"Cornwall"	24	22,000
,,	"Commonwealth"	16	18,000
,,	"Queen"	15	15,000
,,	"Argyll"	16	16,800
,,	"Hindustan"	18	14,400
,,	"Black Prince"	20	18,800
,,	"Duke of Edinburgh"	20	18,800
,,	"Britannia"	18	14,400
,,	"Hibernia"	18	14,400
,,	"Africa"	18	14,400
,,	"Lord Nelson"	15	16,750
,,	"Minotaur"	25	27,000
H.M.S.	"Dreadnought"	18	23,000
..	"Indomitable"	31	41,000
,,	"Bellerophon"	18	23,000
,,	"Superb"	18	23,000
,,	"St. Vincent"	18	24,500
,,	"Vanguard"	18	24,500
R.I.N.	"Napoli"	22	19,000
,,	"Roma"	18	20,000
,,	"San Marco"	14	20,000
B.N.S.	"San Paulo"	18	23,500
,,	"Rio de Janeiro"	18	23,500
C.N.S.	"Capitan Prat"	10	10,000

"WHITE-FORSTER" BOILERS

have been supplied to the following :—

BRITISH NAVY :

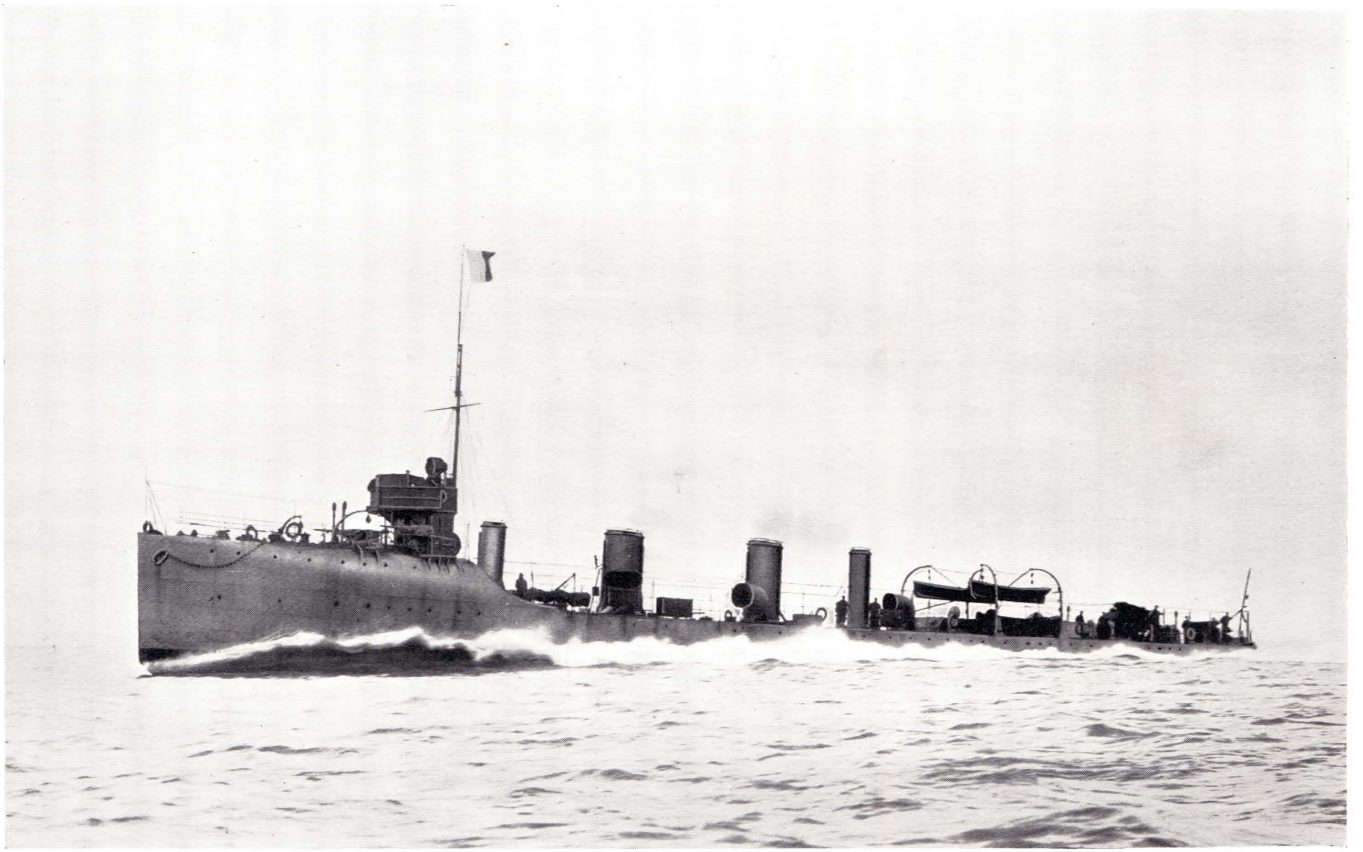
	No. of Boilers.	Horse Power.
H.M. Torpedo Boat No. 114	2	3,100
H.M. Torpedo Boat No. 115	2	3,100
H.M. Torpedo Boat No. 116	2	3,100
H.M. Torpedo Boat No. 117	2	3,100
H.M. Torpedo Boat No. 1	2	4,000
H.M. Torpedo Boat No. 2	2	4,000
H.M. Torpedo Boat No. 3	2	4,000
H.M. Torpedo Boat No. 4	2	4,000
H.M. Torpedo Boat No. 5	2	4,000
H.M. Torpedo Boat No. 13	2	4,500
H.M. Torpedo Boat No. 14	2	4,500
H.M. Torpedo Boat No. 15	2	4,500
H.M. Torpedo Boat No. 16	2	4,500
H.M. Torpedo Boat No. 25	2	4,500
H.M. Torpedo Boat No. 26	2	4,500
H.M. Torpedo Boat No. 27	2	4,500
H.M. Torpedo Boat No. 28	2	4,500
H.M. Torpedo Boat No. 025	2	615
H M. Torpedo Boat No. 033	2	700
H.M. Torpedo Boat No. 078	2	750
H.M. Torpedo Boat No. 100	1	1,000

BRITISH NAVY :

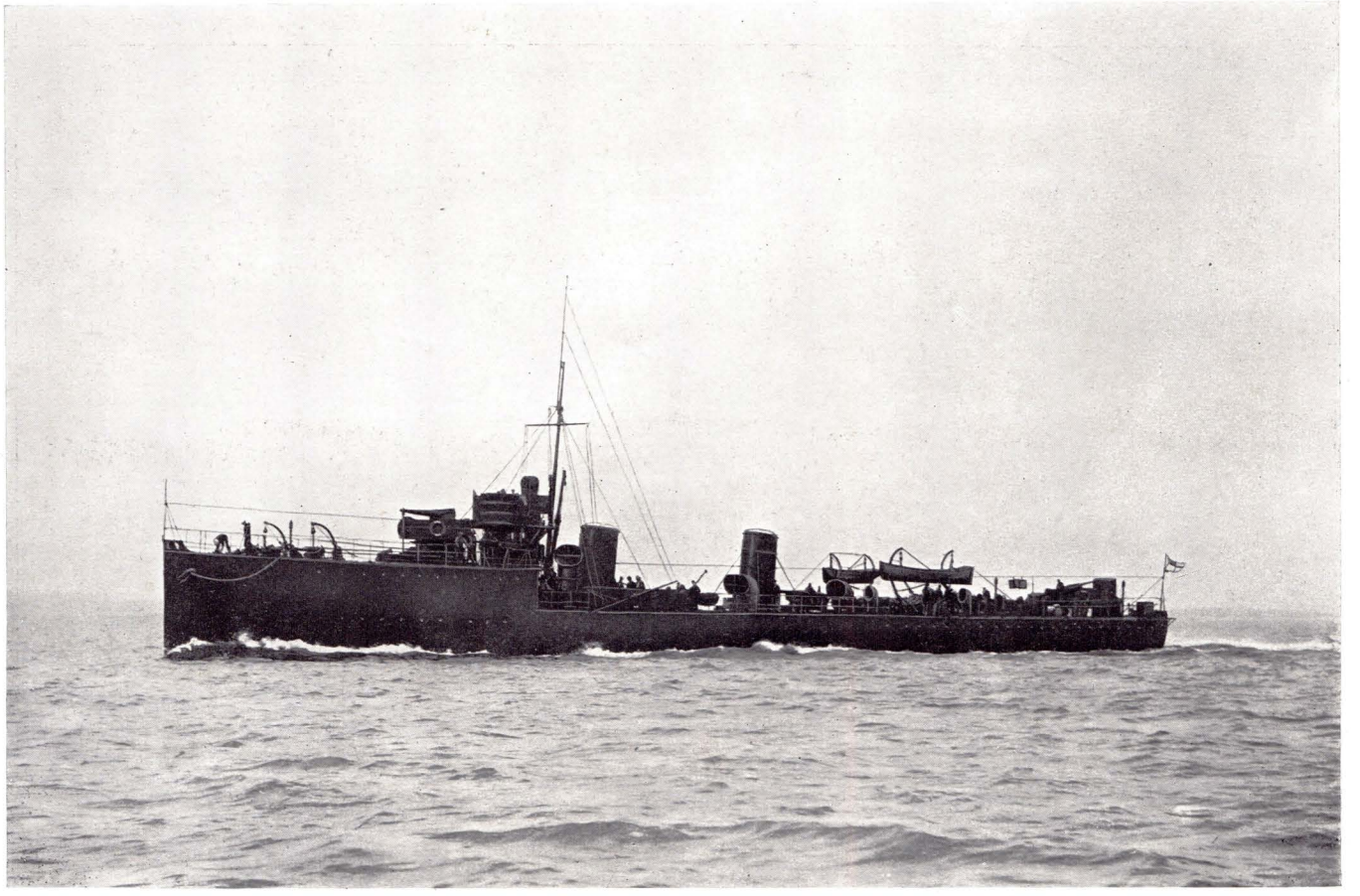
	No. of Boilers.	Horse Power.
H.M. Torpedo Boat No. 102	1	1,000
H.M. Torpedo Boat No. 103	1	1,000
H.M. Torpedo Boat No. 026	1	660
H.M. Torpedo Boat No. 079	2	1,000
H.M. Torpedo Boat No. 027	2	660
H.M. Torpedo Boat No. 081	2	1,350
H.M. Torpedo Boat No. 035	2	1,000
H.M. Torpedo Boat No. 036	2	1,000
H.M. Torpedo Boat No. 037	2	1,000
H.M. Torpedo Boat No. 038	2	1,000
H.M. Torpedo Boat Destroyer "Ness"	4	7,350
Destroyer "Nith"	4	7,350
Destroyer "Conflict"	3	4,500
H.M.S. "Mohawk" -	6	17,400 about
H.M.S. "Saracen" -	6	17,400 about
H.M.S, "Crusader" -	6	17,400 about
	89	**152,535**

Making a total of **89 Boilers,** in addition to various Colonial Vessels, Yachts, Lifeboats, Stern Wheelers, Pinnaces, Launches &c. representing a **further 40,000 h.p.**

On the following pages we give a few illustrations of vessels fitted with the "WHITE-FORSTER" BOILERS.

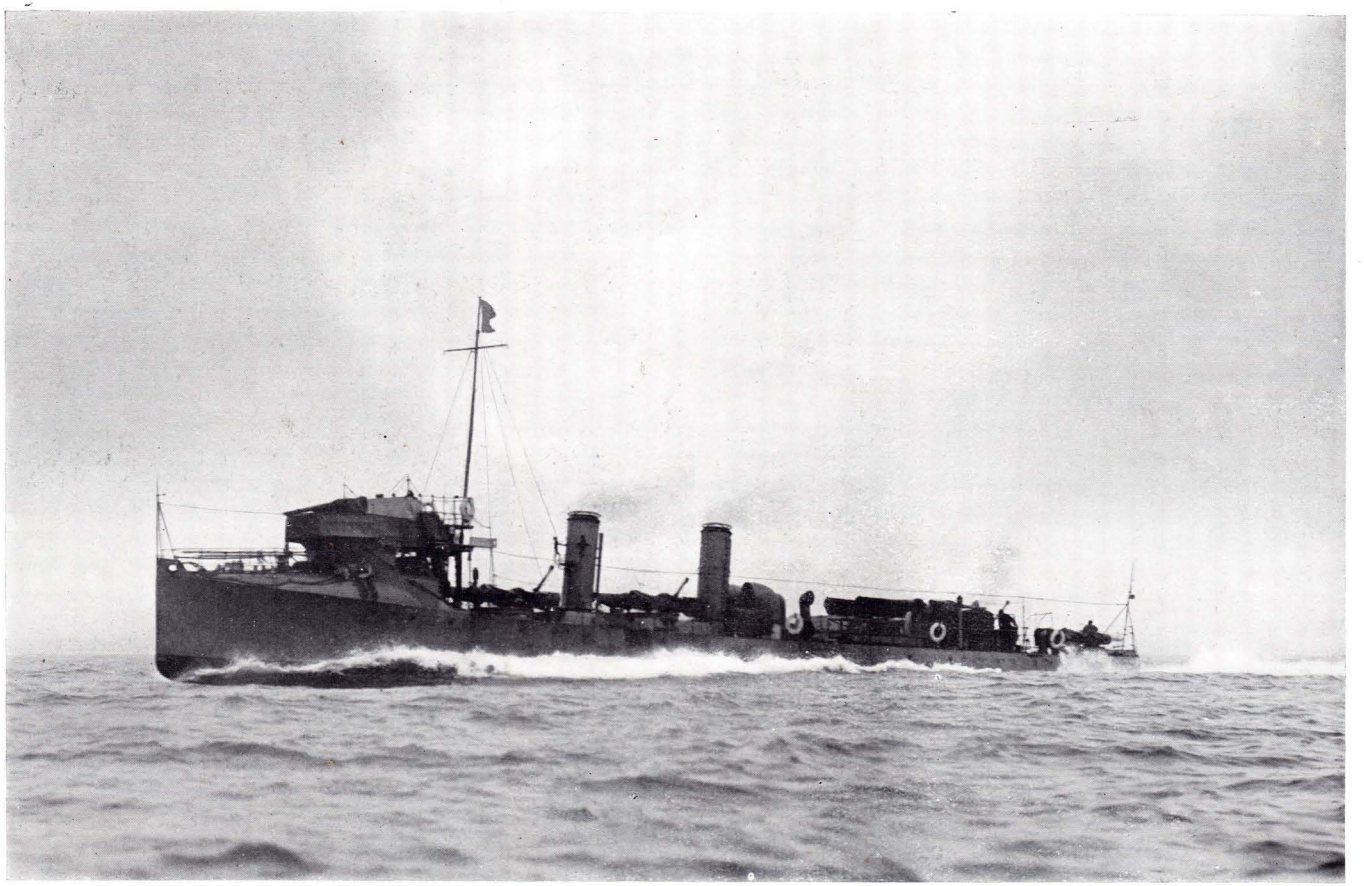


British Navy Ocean-going Destroyer "MOHAWK." Speed, 34·5 knots.
Turbine Machinery. Boilers adapted for Oil Fuel.

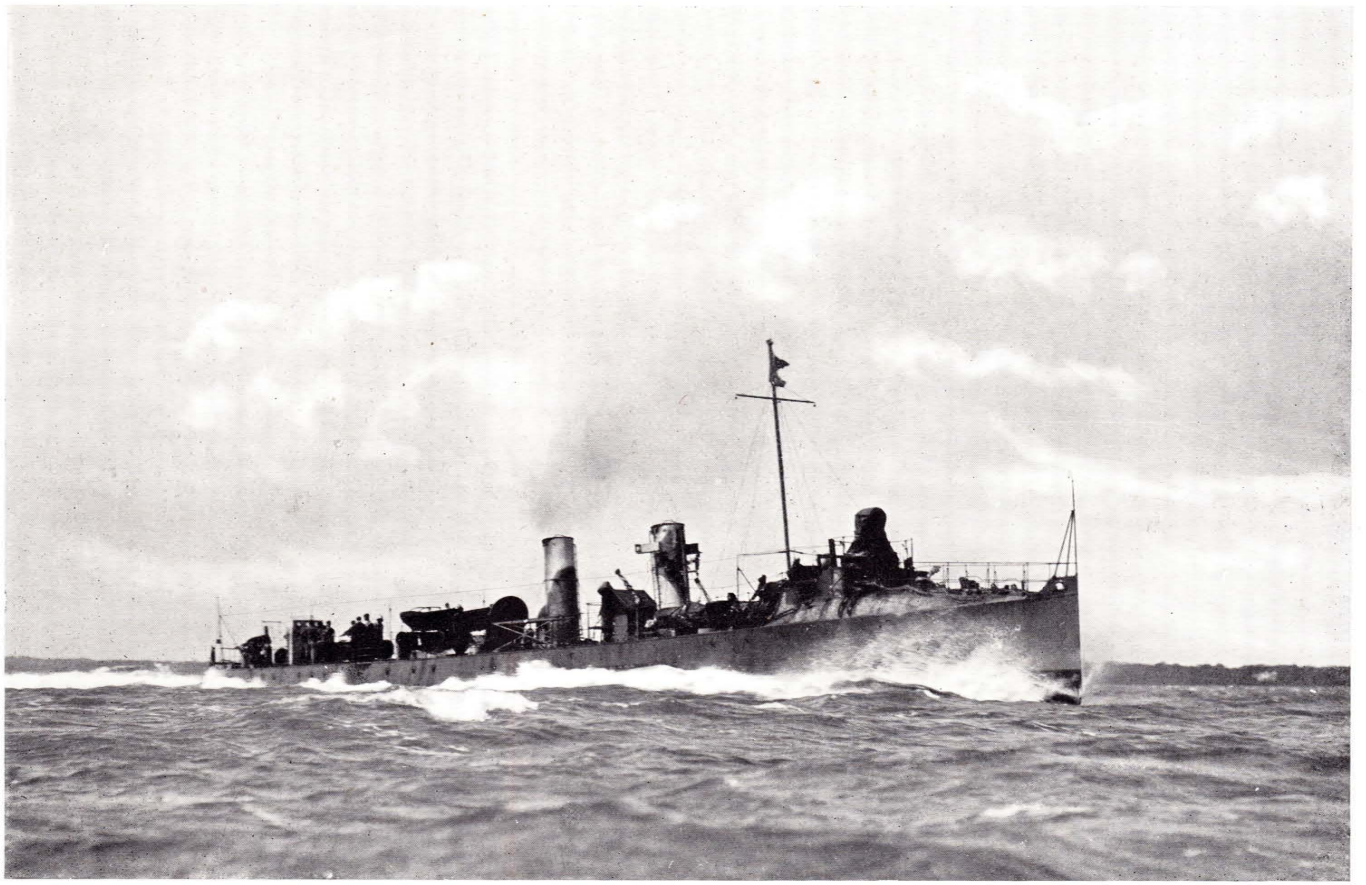


H.M.S "NESS." River-class Destroyer. 7,350 I.H.P. 25·6 knots. Length, 225 feet.
Coal consumption on 4 hours full speed official trial = 1·95 lb. per I.H.P. per hour.
,, ,, ,, 12 ,, trial at 13½ knots = 1·58 lb. per I.H.P. per hour.

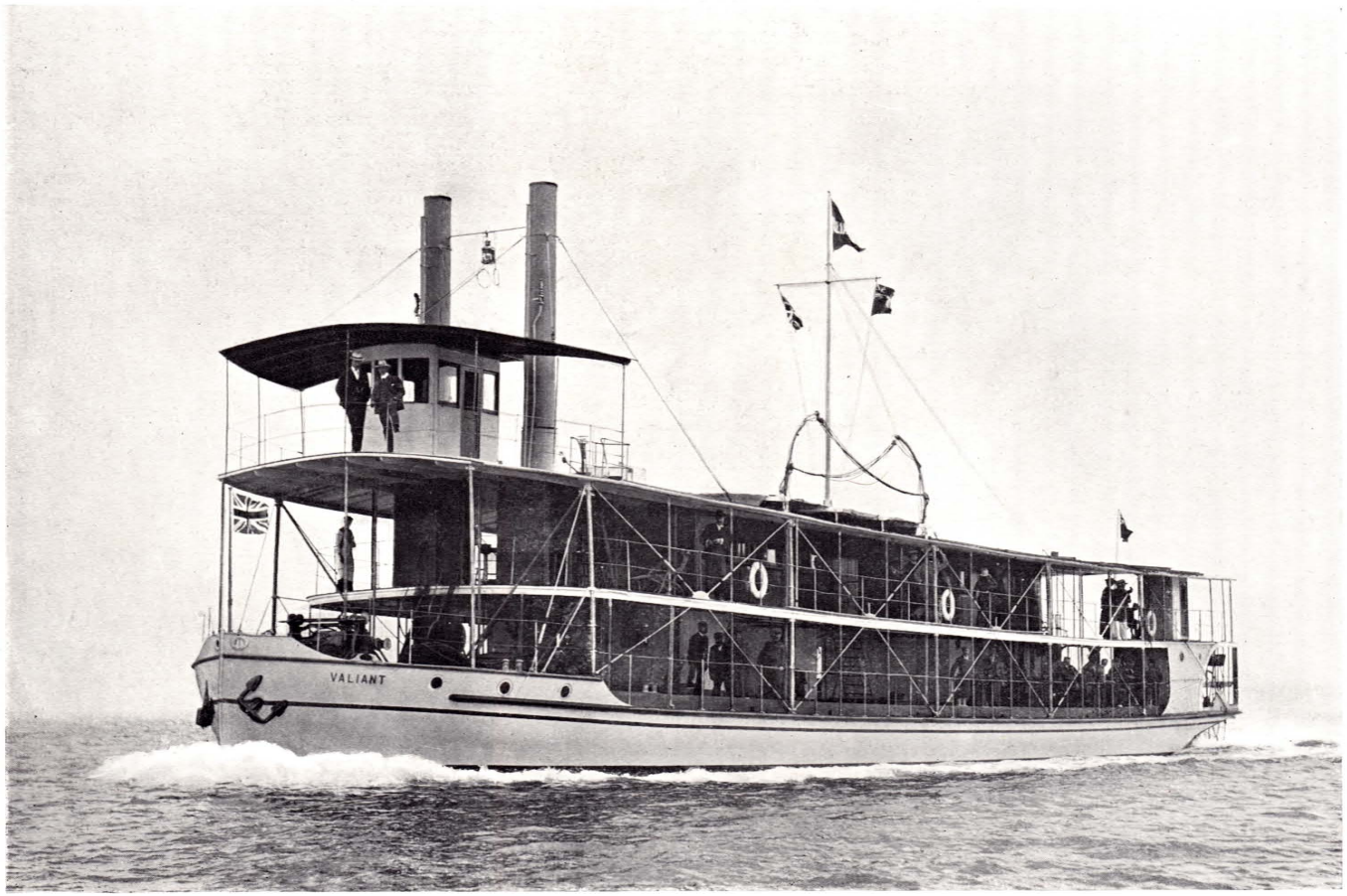
H.M.S. "CONFLICT." 4,500 I.H.P. 27 knots.
Length, 210 feet.



First-class Torpedo Boat No. 1. 4,000 I.H.P. Turbine Machinery manufactured by J. SAMUEL WHITE & COMPANY, Ltd., under license from The Parsons Marine Steam Turbine Co. 27 knots. 175 feet long. (Late Coastal Destroyer "CRICKET.")
Oil Fuel consumption on 8 hours' full speed official trial = 1·366 lbs. per I.H.P. per hour.

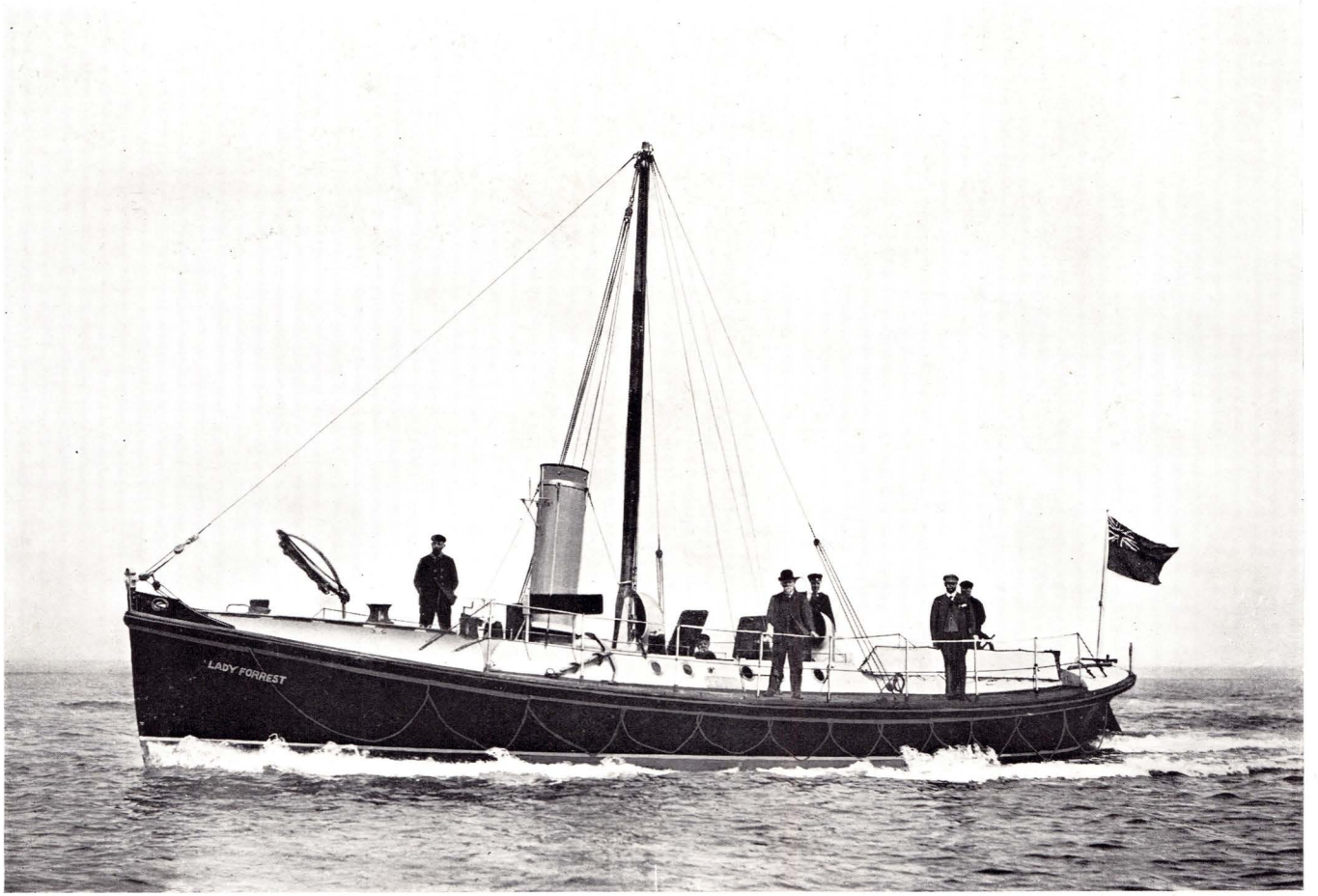


First-class Torpedo Boat No. 116. 3,000 I.H.P. 25·5 knots. 165 feet long.
Coal consumption on 4 hours' full speed official trial = 2·002 lbs per. I.H.P. per hour.
,, ,, ,, 12 ,, trial at 15·6 knots = 1·34 lbs. per I.H.P. per hour.

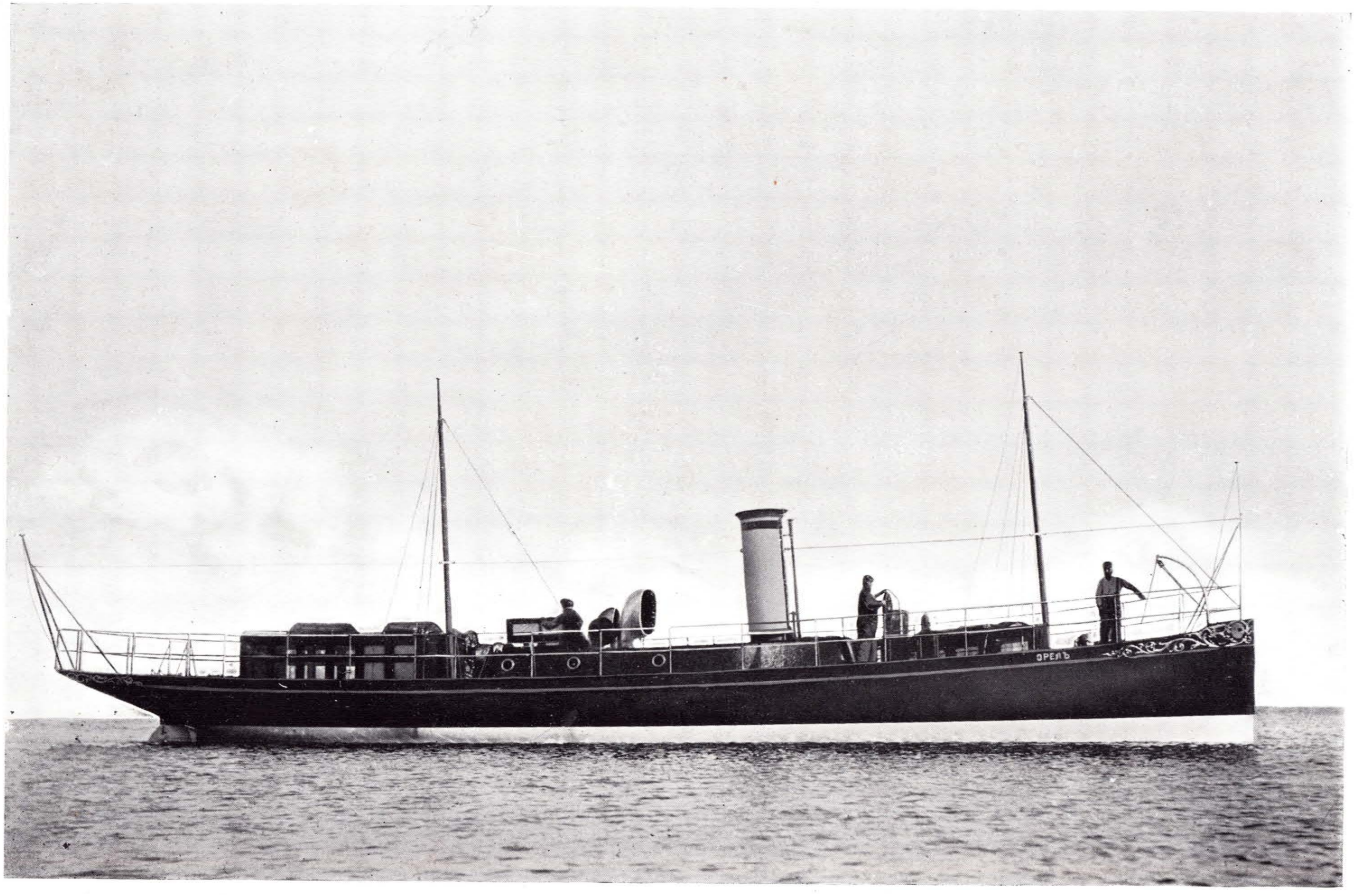


Stern Wheeler "VALIANT," for Southern Nigeria. Length, 145 feet. Breadth, 27 feet. Draft, 2 feet. I.H.P. 320.
Speed, 10 miles per hour. Carrying capacity at above draft, 30 tons.
Two Boilers with large tubes and grates to suit wood fuel.

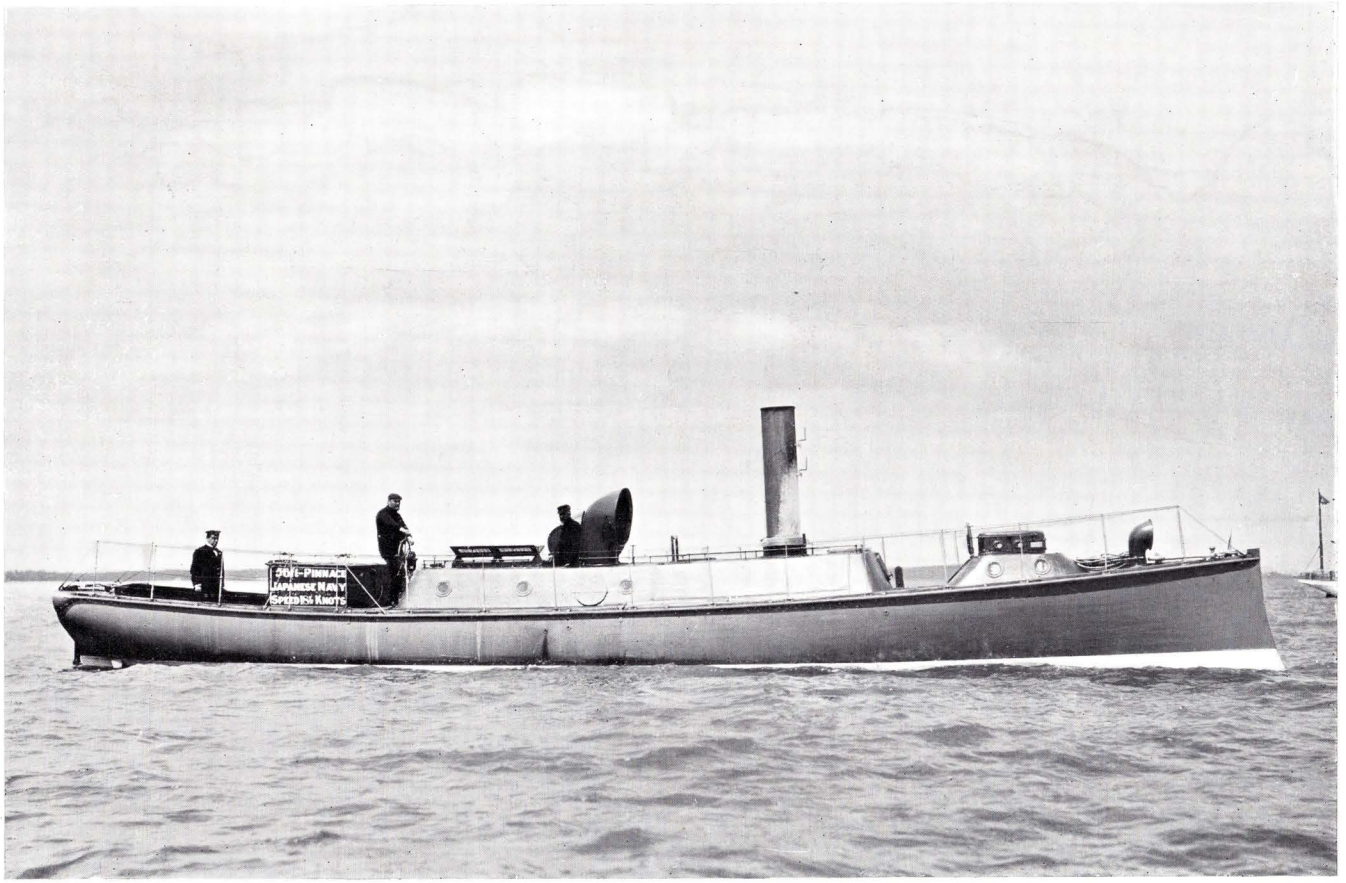
One of the three Lifeboats supplied to the National Lifeboat Institution.



Steam Lifeboat for Western Australia. Pilot Service.

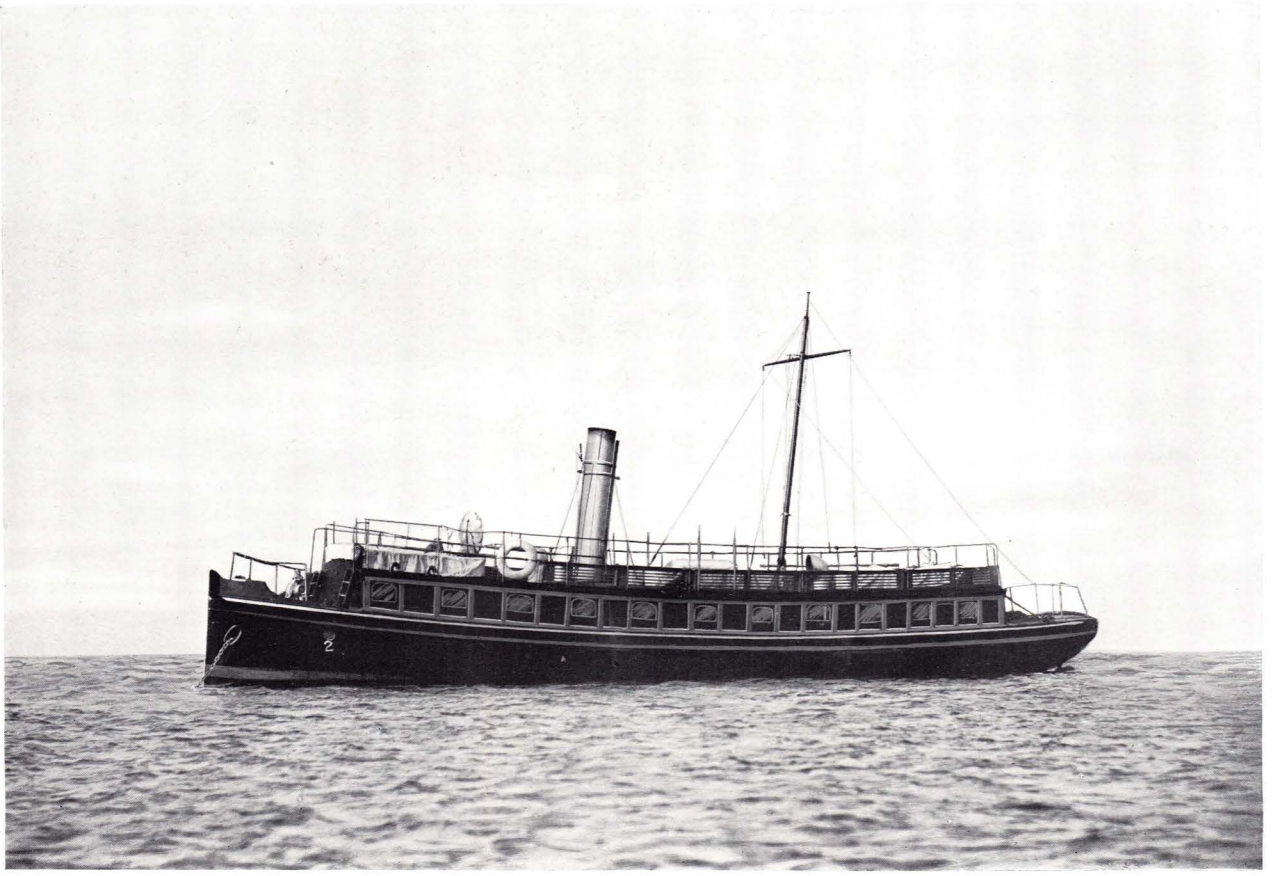


Steam Launch "OREL," for Russian Embassy (Port Arthur).

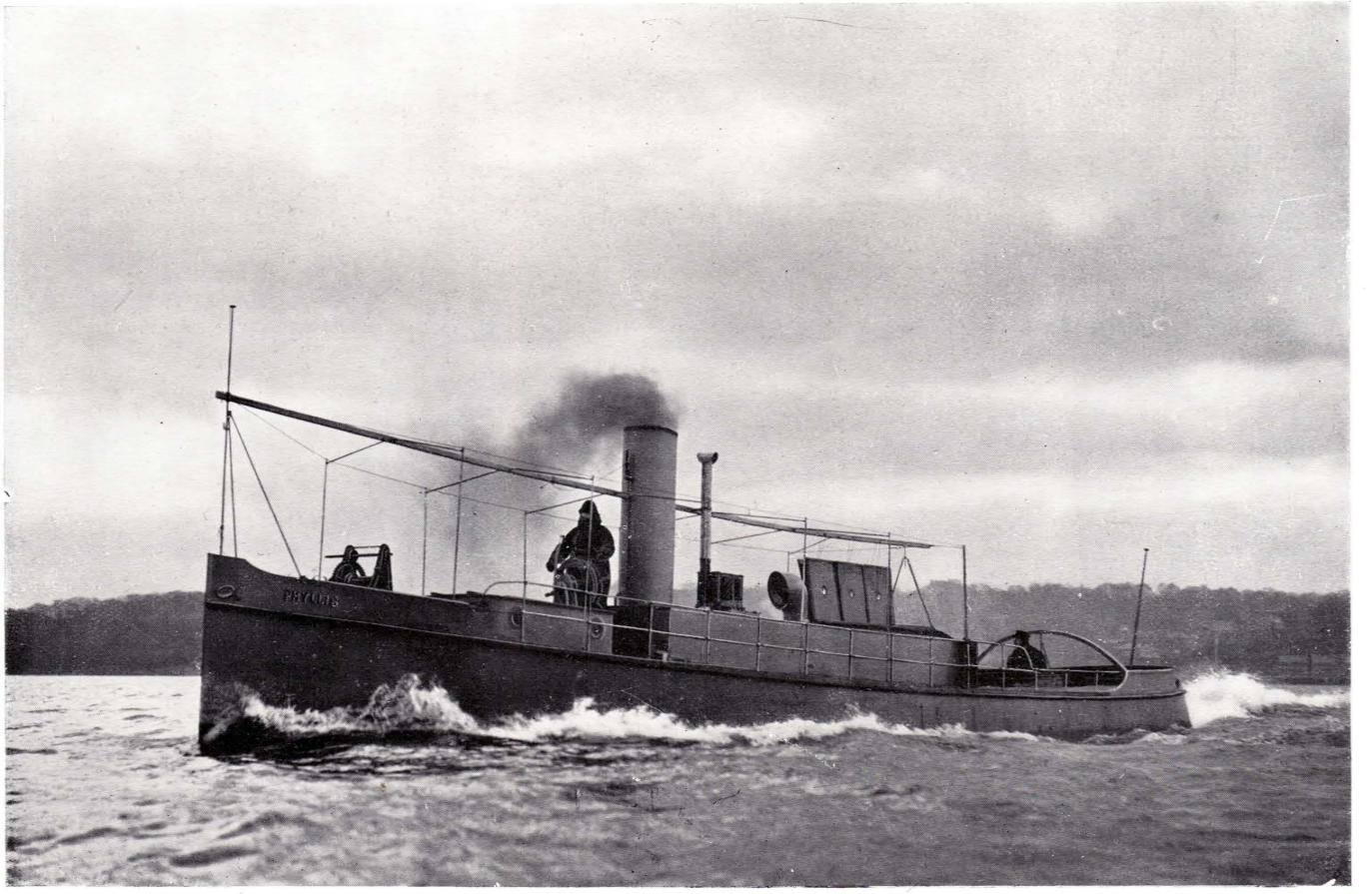


56-ft. Pinnace for Japanese Navy.
Official mean speed, 18½ knots. Actual speed obtained, 19·256 knots.

Standard Admiralty 56-ft. Pinnace. Speed, 16·33 knots.



Instructional Steam Launch for Cadets, Royal Naval College, Osborne.



Twin Screw Steam Towing Launch. Length, 65 feet. Breadth, 10 feet. Draught, 2 feet 6 inches.
Carrying capacity at above draught, 5 tons. Speed per hour at above draught, 13 miles. Screws in Tunnel.